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A CASE FOR "BULK HANDLING" IN W.A.

GEO. L. SUTTON, Director of Agriculture.*

Wheat is transported from the farm to its destination either loosely or in bags.

"Bulk Handling" is the term given to the method of handling or transporting loose or bulk grain as distinct from handling it in bags. Bulk wheat flows readily and, in consequence, it can be handled entirely by mechanical means and very largely like water; it will run, it can be poured and it can be pumped. The bulk grain is elevated or transported horizontally by power and when elevated its flow by gravity it directed to where desired. In short, the principle underlying "bulk handling" is "up by power and down by gravity."

The machinery used for actually elevating the loose grain is called an "elevator," but by custom this word as now used also refers to the building in which this portion of the plant and contiguous bins are housed, and also includes the additional storage bins, which are sometimes attached. In the latter case the building containing the elevator proper is known as the "Working House." The "elevator" located at the port is called a "Terminal." Because the "elevator" is such a prominent feature of bulk handling the system of handling grain in bulk is also known as the "elevator system."

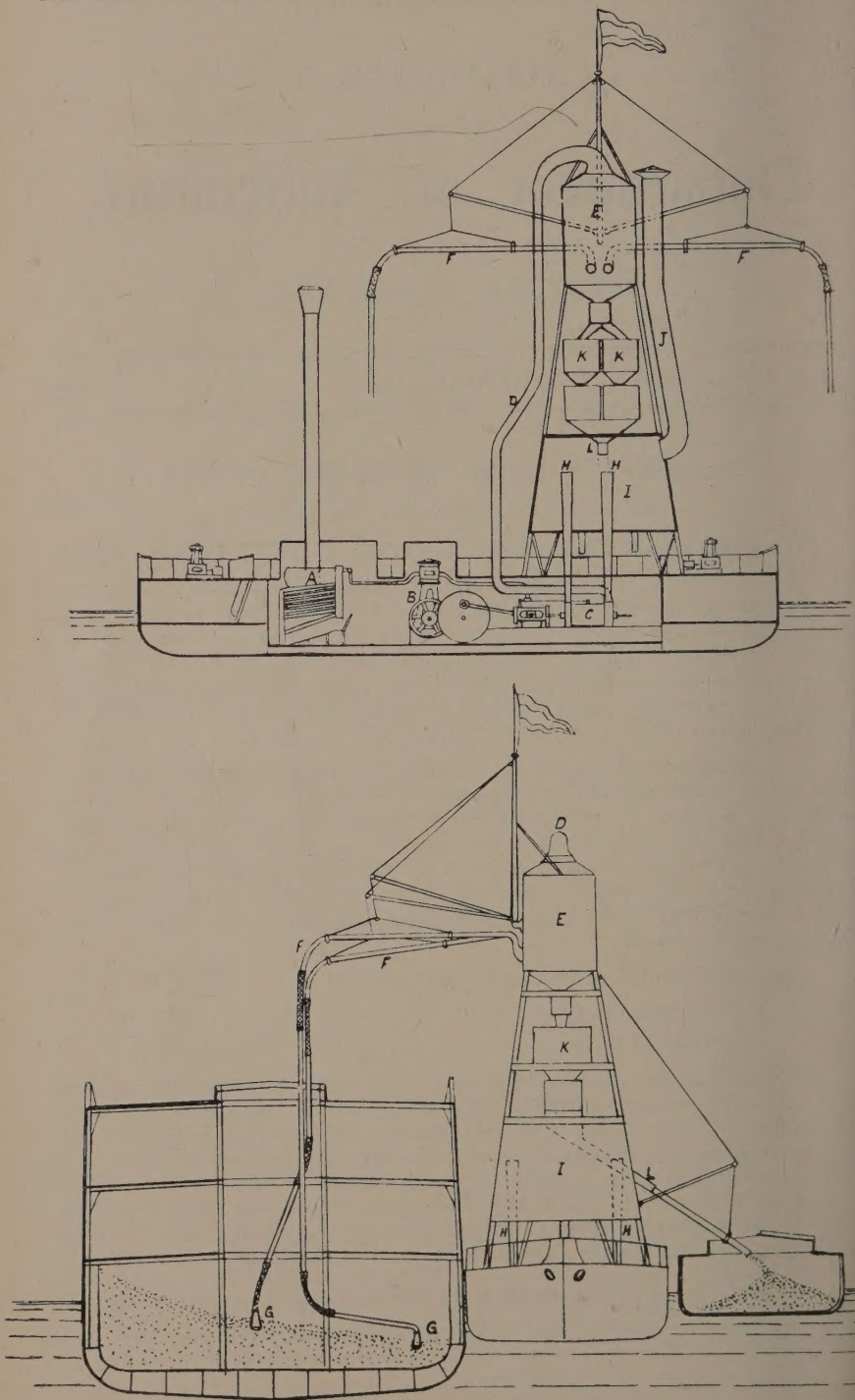
Bulk wheat is lifted or elevated by two methods—

1. The pneumatic system, and
2. The bucket system.

Pneumatic elevators operate by suction; if the mouth of a tube through which air is being drawn at a sufficiently rapid rate is lowered near the surface of the grain, the latter will be drawn up into the tube and carried along with the air. The illustrations herewith are those of a floating pneumatic elevator located at Bremerhaven, in Germany.† This has a capacity of 75 tons per hour and is erected on an iron punt. The motive power is supplied by the boiler A, and the vertical compound steam engines B, which drive the coupled air pumps C. These exhaust the air through the tube D, from the vacuum chamber E, creating a

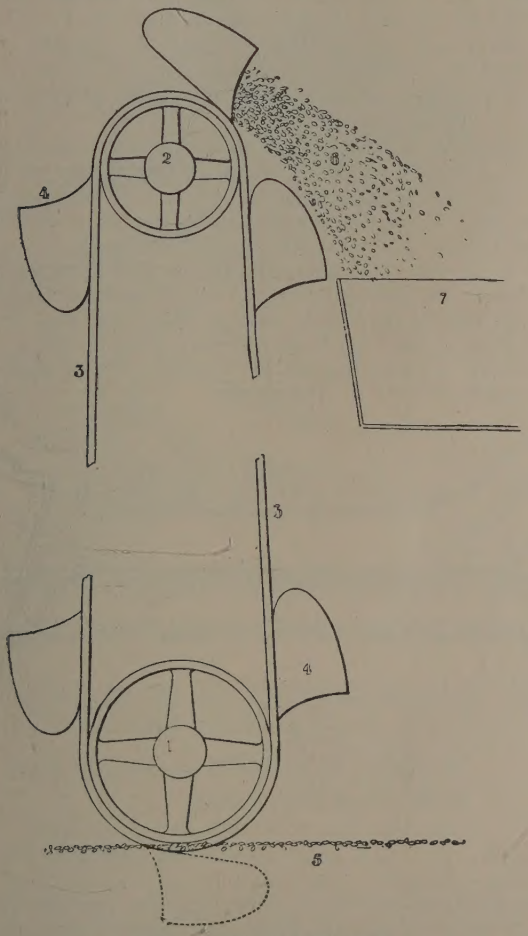
* Paper read before the W.A. Branch of the Economic Society of Australia and New Zealand on 24th June, 1932.

† "The Continental System of Grain Storage," by Oscar Schulze—*Agric. Gaz.*, N.S.W., Dec., 1901.



FLOATING PNEUMATIC ELEVATOR, SHOWING PRINCIPAL PARTS ONLY.
By Oscar Schulze, *N.S.W. Agric. Gazette*, Dec., 1901. (*By courtesy N.S.W. Dept. of Agric.*)

vacuum of about 12 lbs. With this surplus of atmospheric pressure air enters into the flexible suction tubes F through the nossel G, which is inserted into the grain and handled so that the air draws with it a large proportion of grain and deposits it into the vacuum chamber E, freed from dust and husks which are exhausted from chamber E with the air, and after passing through the air pumps and exhaust tubes H, are caught in the dust chamber I, from which they are drawn off at the bottom and bagged or otherwise disposed of, while the dust-free air escapes through the funnel J. From the vacuum chamber the grain passes through alternately acting automatic weighing machines K into the shoot L, which delivers



THE "BUCKET" ELEVATOR.

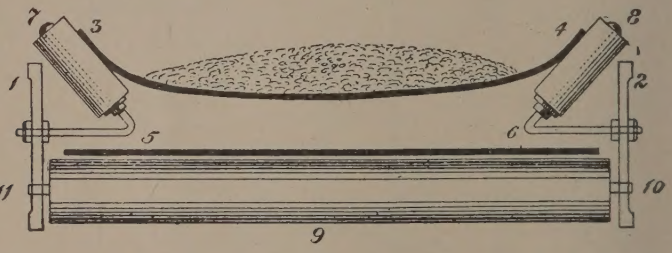
Rough diagram to illustrate the action of an elevator belt. The pulleys 1 and 2 carry an endless band, 3, to which are riveted buckets, 4. As the buckets pass round the lower pulley they dip into the grain, 5, and fill themselves. As they pass over the upper pulley they shoot the grain into a trough, 7. The distance from the lower pulley to the upper is over 100 feet in the largest elevators.

(By courtesy N.S.W. Dept. of Agric.)

it either to its destination or, if it has to be lifted again, into another elevator. This system possesses the advantages of speed and greater flexibility than the Bucket system, but it has not been so generally adopted, because of its greater initial cost.

The Bucket system is by far the more common. In this system an endless band passes round two pulleys, placed respectively at the bottom and top of the elevating device, technically known as the "elevator leg" or simply "leg." On this endless band "buckets" or "cups" are placed at intervals; as each of these passes around the lower pulley it fills by dipping into the grain contained in a hopper, and after passing round the upper pulley it discharges its load into a receiving hopper or spout. This plan is now very generally adopted in connection with harvesting and thrashing machinery, for instance, when the grain is elevated from the bottom of the winnower to another section of the machinery for bagging or further treatment.

Though loose wheat will flow it will not find its own level as water does; its angle of repose is about 23deg., and, therefore, to ensure that wheat will flow it is necessary that the spout through which the wheat is to flow shall have a greater inclination than this. To provide for this the elevator leg is raised above the tops of the receiving bins and high enough to ensure the necessary slope from the head of the elevator to the bin. It is, therefore, obvious that the number of bins which can be filled from an elevator leg by gravity will be governed by the height of the latter and the distance of the former from it. There are thus limitations to the number of bins which can be filled directly by gravity, and, in consequence, elevators in which all the bins are filled by gravity from the elevator head are confined to comparatively small elevators at country sites.



Cross section of a horizontal grain-belt taken near one of the pairs of oblique rollers used to keep the edges of the belt somewhat raised.

1 and 2, sides of the long framework.
3, 4, edges of the belt.
5, 6, returning portion of belt.
7, 8, oblique rollers for turning up the edge of the belt.
9, roller for support of 5, 6.
10, 11, bearings of the rollers 9.

By Dr. N. A. Cobb, *N.S.W. Agric. Gazette*, Dec., 1901.

(By courtesy N.S.W. Dept. of Agric.)

When the number of bins to be filled is greater than can be dealt with by gravity from a central "leg," as in large or terminal elevators, the bulk wheat is transferred horizontally by means of a conveyor belt. These belts are usually made of rubber or rubber composition and vary in width from 1 to 3 feet. These run on oblique rollers, one of which is placed on each side of the belt at intervals of 15 to 20 feet, determined by the width of the belt, and which give a concave curvature to the belt. A diagrammatic section of a conveyor belt is illustrated herewith. Whilst they usually run horizontally they will also work satisfactorily on a grade of 1 in 10 if correct speeds are maintained.

The grain is delivered from the spout at the head of the elevator leg on to the centre of the belt, which then transfers it to the bin required, either at the end turning point, when it obviously drops off the belt at it turns downwards over the pulley, or at any intermediate point desired by means of an ingenious zigzag cut-off, as illustrated.

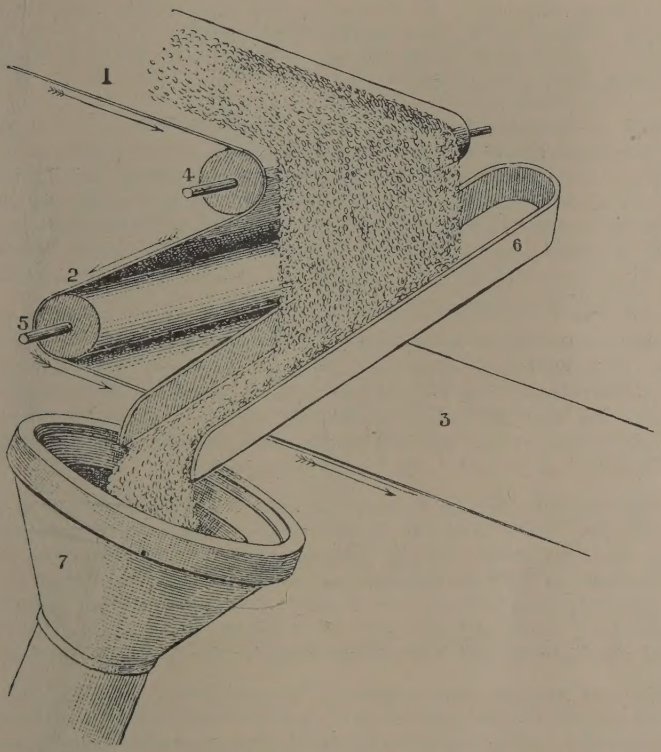


Diagram of a "zig-zag." The grain-carrying belt is shown at 1, 2, 3, and the direction of its motion is indicated by arrows; 4 and 5 are pulleys used to zig-zag the belt. The grain is shot into a trough, 6, which empties into a spout, 7, leading to a bin or elsewhere.

By Dr. N. A. Cobb, *N.S.W. Agric. Gazette*, Dec., 1901.

(By courtesy N.S.W. Dept. of Agric.)

These belts are very generally used for conveying grain from terminal elevators to the wharf-side for delivery into the ship. They are commonly placed in overhead galleries, and may travel several hundred yards, passing en route over the tops of buildings and making several right-angled turns.

Such then are the simple principles upon which all, even the most elaborate elevators, operating on the "bucket" or "cup" principle are designed. The manner in which they are utilised and applied in individual elevators depends upon the special conditions of the site and the ingenuity and skill of the designer.

"Bulk Handling" is power handling to a much greater extent than is possible with bagged grain. Assuming sufficient grain to justify the system and a capital

cost of installation not in excess of a sum on which the interest and capital fund is not greater than the average annual cost of the containers required under the bag system, the working costs of handling bulk grain must, therefore, be much less than those incurred in connection with handling bagged grain. In times of high or even of reasonable prices the difference may not be of first importance, but in times of low and extremely low prices it becomes a matter of supreme moment as one of the means whereby the costs of production, including transportation, can be reduced. Hence, in Western Australia, with present prices for wheat now actually below the cost of production, the dormant interest in bulk handling has been revived with great intensity.

Wheat is handled in bulk in other countries to a far greater extent than is generally realised by the average Australian, who is so accustomed to bag handling. Most of the wheat received at our main market, Great Britain, is in bulk. The report issued by the Ministry of Agriculture and Fisheries in 1928 indicated that 85 per cent. of the imports of grain going into Great Britain were in bulk and the only countries shipping in sacks were India, Australia, California, and Chili; fom India all the grain shipped was in sacks, but from Australia, California, and Chili a portion was in bulk.

Except on the Pacific coast, bulk handling is general in the United States of America. On the Pacific coast the conditions are very similar to those which obtain in Australia, and until a few years ago wheat was handled entirely in bags, but a transition from bag to bulk handling is now taking place. A recent investigation into the cost of bulk and bag handling there showed an advantage in favour of bulk handling of 16.4 cents (8.2 pence) per bushel.

In Canada bulk handling is universal, and in 1931 there was storage capacity for 417,000,000 bushels of grain. In the Prairie provinces there were 5,872 bulk-receiving elevators at the country stations; about 800 in Manitoba, 3,250 in Saskatchewan, and 1,800 in Alberta. At the Fort William and Port Arthur terminals there is a storage capacity now for 93,000,000 bushels, having increased in 10 years from 54,000,000 bushels. At Vancouver the elevator facilities have increased steadily and now have storage capacity for 16,000,000 bushels.

Under the bulk handling system the American or Canadian farmer brings his wheat to the country elevator in an ordinary box wagon in the summer or on a sledge during the winter when the roads are ice-bound. The wagon or sledge is driven on to a platform where it is weighed. The receiving platform has a dumping or tilting device, known as the "dump sticks," and the conveyance, after being weighed, is then tilted backwards by these, the slide is pulled out of the slot in the tail-board, and the grain runs into the receiving hopper in a few minutes. From the receiving hopper it is taken by the cups from the boot or bottom of the elevator leg to the head of the elevator and there transferred to the bin to which it is assigned. This is done by means of a turn-head spout at the top of the elevator, which is operated from the floor level of the working house.

In a small elevator the device for diverting the wheat from the elevator hopper may be quite simple and consist of one spout only; in large elevators quite a battery of spouts would be available to take the wheat from the head of the elevator, or from a zigzag on a belt.

En route to the bin the grain may, however, be cleaned and freed from chaff and other unmillable material, or this operation may be delayed until a more convenient time, or even until just prior to the wheat being railed away from the country elevator.

As most country elevators in Canada and the United States are privately owned, it is customary to weigh the wheat as it leaves the elevator, and for this purpose the individual elevators are equipped with weighing machines, the size varying in accordance with the elevators. In large elevators as much as 2,500 bushels would be weighed in one operation, and almost as delicately as a chemist weighs a drug on his balance.

In Canada and the United States, owing to the rigorous winter conditions, covered railway trucks are in general use, and so on being despatched from the elevator the wheat is sent away in bulk in a covered truck, which usually holds from 30 to 40 tons. This is of greater capacity than our open wagons which are so suitable for our climate. The trucks are unloaded into either storage or "primary" elevators, as they are called in Canada, and which are placed on the shores of the lake or into terminal elevators at the ports. From the conveyor belts it is poured, by large spouts, into the ship's hold. As it passes down these chutes it is much easier to take a sample for inspection or record purposes than it is to take it from separate bags under the system which obtains in Western Australia.

As it is impossible for some of the great Atlantic liners to spare the time to go to a terminal elevator, facilities are provided at some ports, as at New York, for punt elevators to take the grain to the liner. These are so designed, however, that when loaded with bulk wheat, this flows to the foot of the elevator; it is lifted by the ordinary bucket or cup conveyor and then transferred to the hold of the liner whose time is so valuable that it is important that every unnecessary delay should be avoided.

Abundant facilities are available in Europe for handling bulk wheat on its arrival there. Most of the main port mills in the United Kingdom and on the Continent have bulk facilities with storage capacity from 100,000 to 1,000,000 bushels. The number that is available, in addition to showing in no uncertain way that ample bulk facilities are available, are remarkable for variety in their designs, but all are modifications of the elevator and grain belt and all are worked mainly on the principle of "Up by power and down by Gravity."

Dr. N. A. Cobb* in 1901 pointed out that even at continental ports, where there were no permanent elevators, bulk cargoes could be unloaded by means of portable appliances and, as a specific case, illustrated in detail, the unloading of a bulk cargo at Antwerp. The cargo was ex the steamer "Friesland," of the Red Star Line; it was one of maize and had to be discharged into canal boats, for various parts of Belgium, into bags for local consumption at Antwerp, and on to the wharf in loose piles to await sale and transportation.

As Canada and America have adopted bulk handling, and apparently with advantage to themselves, it is pertinent to ask "What objections are there to handling wheat in bulk in Australia?" It has been said that, though bulk handling is admirably suited for the conditions which obtain in Canada, yet, because of the different climatic and other conditions obtaining in Western Australia, it is not likely to be suitable there. This, however, is not so. Because of the climatic conditions, combined with difficulties of transportation over inland waterways and over tremendously long distances, the slower and more costly bag handling method is entirely unsuitable for Canada. Had the Canadian farmers been compelled to retain their original bag system it is certain that the development of Canadian lands for wheat production could not have reached its present stage. It does

* "Grain Elevators," Dr. N. A. Cobb, *Agric. Gaz.*, New South Wales, Feb., 1901.

not follow that, because the more favourable Australian conditions have enabled the bag system to persist for so long, the bulk handling system cannot be introduced now with advantage.

Wheat growing in Canada has progressed largely because of the aid it has received from bulk handling; in Australia wheat growing has progressed not because of bag handling, but in spite of it. As has been pointed out by Dr. Cobb in connection with Californian conditions, bag handling is a handicap which our growers have carried by virtue of their flat areas, peculiar climate, and wonderful harvesting machinery.

Since the adoption of bulk handing in Australia was first advocated the objections against its introduction have been many and various. These have been rebutted from time to time and it is significant that, after trial, there is never a suggestion in the country that has adopted it to revert from bulk handling to bag handling. One of the earliest objections was that bulk wheat was unsuitable for transport over the long ocean voyage necessary to reach the European market. To determine this point an experimental bulk shipment was despatched by the White Star Liner "Persic" in 1900. Since then, however, numerous cargoes have been sent to Europe and to the Chinese and Japanese ports just as safely as with bagged wheat, and to-day the insurance on bulk and bagged wheat is the same.

To those unfamiliar with bulk handling it may be thought that parcels of bulk wheat cannot be shipped, but this is disproved by the fact that liners from American-Canadian ports take parcels of bulk wheat, as has also been done by the White Star liners from Australia, though to date this has not been done by the P. & O. and Orient mail boats.

Another one of the objections raised even now to the bulk handling system is that it will limit our markets because it is alleged that the main centres to which our wheat is exported are not equipped with bulk handling facilities. This is not so, for it has already been stated that in our main market, Great Britain, there are abundant facilities for handling bulk wheat.

During the last two years our trade with China and Japan has expanded. In Japan there are facilities for bulk handling at the main ports. In China it is significant that up to the first week of January of the present year (1932) charters had been entered into for the shipment of 2½ million bushels of bulk grain from Sydney to Shanghai.

Whilst those without bulk handling facilities may prefer to have wheat in bags while it is available, yet, if the change is made to bulk, there is no doubt that they will either provide bulk handling facilities at their receiving ports or arrange to bag the wheat on arrival. Even if, however, they refused to do this it would be quite possible to cater for their trade, as the wheat could be bagged at the terminal port before despatch, and this would be perferable to the present arrangement, as it would give our farmers all the advantages of cheaper handling. In addition it would enable the bags to be placed on board in the best possible condition, so that on arrival at their destination their residual value would be greatest. Further, each bag could contain the same definite weight, which reports indicate would be appreciated by the customers.

Dr. Cobb has shown that at Antwerp provision is made for bagging bulk grain at destination for those who desire their supplies in bags. Surely this is more in accordance with the fitness of things that those who require bags should supply them and pay for them. This should especially apply to India, which is an occasional customer for Australian wheat, but has no bulk handling facilities, and where the bags are made from material grown in that country.

Wheat has been handled in bulk in New South Wales since the season 1920/21. It has been claimed that the New South Wales system is an unsound and uneconomic one; that the capital cost has been too great, and that during the past number of years it has been in operation the burden on the taxpayer has been too great to warrant the adoption of the system in other States. This is admitted on all sides, for the capital cost was unnecessarily and abnormally high for present day requirements, and the storage is excessive and not well placed.

It must be recognised that the New South Wales system was initiated during the War period, and largely as a storage scheme in order to prevent the serious losses which were occurring in connection with the stored wheat, because of our inability to dispose of it. In Western Australia a similar but possibly less acute difficulty had to be faced in order to protect the bagged wheat in the compulsory pools from the ravages of insect pests and other vermin; the sheds were enclosed with a less durable material than concrete, but which had to be scrapped at breakdown value on the completion of the storage period, and when the wheat was disposed of. In Western Australia this expense was paid out of the proceeds of the crop which incurred it. In New South Wales it has been debited to the elevator system, and because of this, some deduction from the capital cost, as a handling plant, would seem to be justified.

In examining the New South Wales position it was also found that, when the system was established, the farmers for some reason or other which it is difficult for us to understand refused to use it, for instance, in the first year it was available only 23 per cent. of the available storage capacity was used, and it was not until last year that it was utilised to an extent above its storage capacity. But the position is changed, and now farmers are using it very readily, and in districts where facilities are not available they are even clamouring for facilities to be installed.

It is true that if the possibilities of the New South Wales elevator system be judged by what has happened in the past then there can be no doubt that it has been very unprofitable, but is it reasonable to do so? Is it not more important to judge the soundness and possibilities of the system by what is happening at the present time? This is done in other activities. Do we to-day judge the possibilities of the motor car by what it was capable of 25 to 30 years ago? Do we judge of the possibilities of aviation by the triumphs of the Wright Brothers, or by the admirable record of our own Airways Company? Do we judge the possibilities of wheat production in Western Australia by what was considered possible 20 years ago? The obvious answer to this is "No," and that is the position with the New South Wales system. Is it not rather a triumph for the bulk system, and for its administration and management, that, in New South Wales in 1930/31, the system provided a return of 4⅓ per cent. of the total capital expenditure involved, after making a charge of only 2½d. to the farmers from the farm to the ship, and this despite its admittedly excessive capital, ill-balanced design, and with the utilisation of only 104.18 per cent. of its storage capacity instead of about 130 per cent.

It has been claimed that bulk handling would be handicapped in Australia because of our harvesting methods. The successful operation in New South Wales now definitely proves that this is not so.

Even the advocates of bulk handling were never sanguine enough to imagine that bulk wheat would bring the same price as bagged wheat, as the container of

the latter certainly has some value, but the following letter sent to the Hon. J. Lindsay, Minister for Works, shows that no longer is a premium obtained for bagged as against bulk wheat—

The Farmers' & Graziers' Co-operative Grain
Insurance and Agency Co., Ltd.,
Circular Quay,
Sydney, 2nd June, 1932.

Mr. J. Lindsay,
Minister for Works,
Department of Works and Labour,
Perth, W.A.

Dear Mr. Lindsay,

Whilst the nominal quotation for bagged wheat on the day referred to by you was slightly in excess of that for bulk, I am in a position to inform you most definitely that for quite a period quotations for bulk wheat have been in excess of those for bagged. For example, the estimated f.o.b. price for bagged wheat at one period was around 3s. 5¼d., representing an approximate return to the grower of 2s. 8½d.—on the same day there were buyers for Bulk Wheat Warrants at 3s. 5½d., giving a return of 2s. 9½d. to growers.

This information I feel sure will convince you that, although in the early days of the elevator system in this State, there was a strong prejudice amongst buyers and also growers, of later years, and particularly the last two, the system has become increasingly popular not only with the farmers but with buyers.

We here can sell Bulk Wheat Warrants practically any day, when there are times when we find it extremely difficult to find buyers for bagged wheat.

My opinion is that you should go ahead, if possible, with your elevator scheme, as I feel your farmers will very quickly appreciate the system as much as our growers in this State have done.

Yours faithfully,

(Sgd.) THOMAS B. DONNELLY,

Manager.

The operations of the bulk handling system in New South Wales have shown that the quantity of bagged wheat required for stiffening bulk cargoes is decreasing. At one time it was considered that at least 10 per cent. of the cargo should be in bags. Mr. Harris, the General Manager of the Government Elevators, New South Wales, considers that the average amount of stiffening is about 4 per cent., and that some vessels require no stiffening at all: in 1930/31 there were 8 out of 66 and in 1931/32 2 out of 16 which had none.

The freight on bulk wheat is less than on bagged wheat, the advantage ranging from 2s. 6d. to 3s. 6d. per ton. This is not surprising, for with bagged wheat the ship does not receive payment for the weight of the bags which contain the wheat, but by far the greatest factors influencing the reduction in freight are the harbour charges and overhead capital expenses saved to the ship consequent upon the very much more rapid loading and the reduced expenses for stevedoring. The following instance will illustrate this:—In May last a vessel commenced loading bulk wheat at White Bay, the New South Wales terminal, at 8 a.m.; at 10 p.m. it was completely loaded with 7,500 tons. The same vessel when loaded with bagged wheat at Port Lincoln on a previous trip required 10 days. The time occupied at Port Lincoln was greater than would be

the case at Sydney or Fremantle, where there are very efficient bag-handling appliances, but even at Fremantle the average rate of handling bags may be considered to be 750 tons *per day* compared with 800 tons *per hour* at White Bay, the New South Wales terminal. The amount 750 tons per day is not the maximum with which the facilities at Fremantle are capable of dealing; this is probably twice as much. Nor is the 800 tons per hour the maximum for bulk handling at White Bay; it is 1,200 tons per hour. Broadly, it may be stated that with bulk wheat it is customary to load as much in an hour as in a day with bags.

Even with an efficient bag system a vessel requires almost as many days to load as hours are required under the bulk system. It is believed that, if all the ports in Australia were equipped with bulk handling facilities so that the system became general, the reduction of 2s. 6d. to 3s. 6d. per ton would be increased to at least 5s. per ton.

One of the advantages still claimed for the bag system is that the bag is weighed in as wheat and that the farmer gets paid for it at the same price as the wheat. This is quite true, but just how little advantage this is to the farmer is shown by the following table:—

CASH VALUE OF WHEAT SACKS (2¼LB.) WHEN PAID FOR AT THE SAME RATE AS THE WHEAT THEY CONTAIN.

Price of Wheat.	Value of Sack.	Price of Wheat.	Value of Sack.
	pence.		pence.
1s. 8d.	·75	3s.	1·35
2s.	·90	3s. 4d.	1·50
2s. 4d.	1·05	3s. 8d.	1·65
2s. 8d.	1·20	4s.	1·80

Average price of wheat sacks (10 years)—9·9 pence.

It is seen that, with wheat at 3s. 4d. per bushel, the West Australian farmer receives 1½d. for a bag which on the average during the past ten years has cost him 9.9d., or a loss, not a gain, of 8.4d. on each bag used.

Seeing that the bulk handling system has proved to be suitable for New South Wales conditions, and advantageous to those farmers who can use it, it is natural to ask, "Can it not be adopted with economic advantage to West Australian conditions?" As the result of the initiation of an experimental system by the Westralian Farmers, Ltd., this can be answered definitely in the affirmative. I desire to make acknowledgment of the splendid public service rendered by the W.A. Wheat Pool and the Westralian Farmers, Ltd., in carrying out this experimental system and so definitely demonstrating that bulk handling can be advantageously applied to West Australian conditions. Scores of farmers served by the sidings of Benjaberring, Korrelocking, Nembudding, Yelbeni and Trayning have proved this to their advantage. Some other farmers who are not normally served by their sidings, and who otherwise would have had to use bags, have realised the advantages of bulk handling and have carted their wheat several extra miles to adjacent sidings in order to take advantage of it. This is in accord with the experience in New South Wales; the Manager of the Farmers' & Graziers' Co-operative Grain Insurance and Agency Co., Ltd., states that farmers travel 12 to 15 miles extra in order to take their wheat to sidings where bulk handling facilities are available so as to take advantage of and benefit by them.

The Westralian Farmers' Ltd. experimental adventure into bulk handling was so successful, and so welcomed by the farmers, that the quantity delivered was much greater than could possibly have been foreseen, and in consequence facilities to receive the wheat had to be provided at short notice. Those handling this matter are to be congratulated on the initiative and ingenuity displayed in meeting the unexpected emergency by the bulk heads storage.

The following *pro forma* balance sheeets relating to the operations of three farmers—Messrs. T. H. Wilson, S. W. Chester, and H. Threlfall—who used the bulk handling system, show just what their savings were:—

COMPARISON BETWEEN BULK AND BAG HANDLING COSTS.

Operations of T. H. Wilson, Esq., Wyalkatchem.

Handled 6,000 bus. in bulk, and 1,400 bus. in bags.

Bulk wheat if sold in bags.	£ s. d.	£ s. d.	*Bulk wheat costs.*	£ s. d.
2,000 bags at 8s. 9d. per dozen	72 18 4		200 bags at 8s. 9d. per dozen ...	7 5 10
Less weight of bags (each 2¼lb. paid for as wheat at, say, 3s. per bus. of 60lbs.)	11 5 0		Special bulk handling charge of ½d. per bus. (6,000 bus.) ...	12 10 0
		61 13 4		£19 15 10
Sewing bags (including twine), 2,000 bags at 1½d.		12 10 0	Less value of 200 bags at half-rate = 4s. 4½d. per dozen ...	3 12 11
				£16 2 11
			Advantage in favour of Bulk Handling	58 0 5
		£74 3 4		£74 3 4

Per bus., 2·32d.

Operations of S. W. Chester, Esq., Wyalkatchem (Manager for Hon. J. Lindsay, M.L.A.).

Quantity handled—16,207 bus. in bulk.

Bulk wheat if sold in bags.	£ s. d.	£ s. d.	*Bulk wheat costs.*	£ s. d.
5,330 bags at 9s. per dozen	199 17 6		600 bags at 9s. per dozen ...	22 10 0
Less weight of bags (each 2¼lb. paid for as wheat at, say, 3s. per bus. of 60lb.) ...	30 0 0		Special bulk handling charge of ½d. per bus. (16,207 bus.) ...	33 15 4
		169 17 6		£56 5 4
Sewing bags (including twine), 5,330 bags at 1½d.		33 6 3	Less value 600 bags at half rate = 4s. 6d. per dozen	11 5 0
				£45 0 4
			Advantage in favour of Bulk Handling	158 3 5
		£203 3 9		£203 3 9

Per bus., 2·34d.

Operations of H. Threlfall, Esq., Korrelocking.

Quantity handled, 12,400 bushels.

Bulk wheat if sold in bags.	£ s. d.	£ s. d.	*Bulk wheat costs.*	£ s. d.
4,128 bags at 9s. 6d. per dozen	163 8 0		900 bags at 9s. 6d. per dozen ...	35 12 6
Less weight of bags (each 2¼lb. paid for as wheat at, say, 3s. per bus. of 60lb.)	23 5 6		Special bulk handling charge of ½d. per bus. (12,400 bus.) ...	25 16 0
		140 2 6		£61 8 6
Sewing 4,128 bags at 10s. 6d. per 100 ...	21 13 5		Less value 900 bags at half-rate = 4s. 9d. per dozen	17 16 3
Twine for 4,128 bags at 1s. 6d. per 100 ...	3 1 11			£43 12 3
		24 15 4	Advantage in favour of Bulk Handling	121 5 7
		£164 17 10		£164 17 10
			Per bus., 2·34d.	

The details given for Mr. H. Threlfall's operations are compiled from a letter which he published in the *West Australian* of 22nd January, 1932, but the advantage is not quite the same as stated by Mr. Threlfall. In his letter he debited his operations for the current year with the capital charge of £8, which was the cost of adjusting his waggon to carry bulk wheat, nor did he give credit for the value of some of the second-hand bags which he had purchased for handling his bulk wheat, but which were used at the conclusion of the season for holding oats. In the statement given these items are included.

From these statements it will be seen that the saving ranges from 2.32d. to 2.34d. per bushel. This provides for a special charge of ½d. per bushel in addition to the usual one for bag handling (say 2.772d.), that is a total of about 3¼d. per bushel, which is equal to the charge under the installation proposed by the Westralian Farmers. Is it reasonable to believe that the farmers and others who benefited similarly can be persuaded by any kind of argument that bulk handling is unsuitable for, or unprofitable to, them.

The success of the experimental installation is a solid fact concerning which there can be no argument. It does not follow, however, that its design is that best adapted for general and permanent installation throughout the State. The proposal to instal the design, part of which was eventually installed as an experimental one, was submitted to the Hon. Minister for Works and referred to a Committee, of which the writer of this paper was a member. It was intended by the proposers of the scheme at the time (end of July, 1931) that it should be installed for the 1931-32 harvest, and the Committee was, therefore, asked to report expeditiously upon the proposals. They reported on the 1st August as follows:—"We are satisfied that the scheme is a practicable one, but it has not been possible for the Committee in the limited time at its disposal to say that no better one can be planned."

When it was found that it would not be installed for the current season and more time was available to consider the matter, the same Committee reported on the 1st November as follows:—"We believe that the £1,000,000 would be better applied towards the erection of the more orthodox scheme when money is available."

At the middle of December a sub-committee, of which the writer was again a member, after seeing the experimental scheme in operation, reported as follows:—"Our impressions are that the process suits the farmer and the miller, and that the railways can adapt themselves to it."

The experimental scheme had conclusively demonstrated:—

(a) That bulk handling was suitable for W.A. harvesting conditions;

(b) That bulk handling reduced farmers' costs; and

(c) That the farmers were ready for it.

In this scheme the floors of the bin containers are flat and not hopper-shaped, as is usual with the upright type of container. In consequence it does not provide for as complete mechanical handling of the loose free remaining grain as does the latter. The Committee were therefore convinced that a more complete mechanisation of the handling must result in easier working and greater economy, for cheaper handling charges in perpetuity would more than offset a lower initial capital cost.

The importance and significance of reducing handling costs to the extreme limit is brought out by the fact that a handling cost of 1/10th of a penny per bushel on the handling of 24,000,000 bushels amounts to £10,000 annually, and that this would pay the interest (5 per cent.) and sinking fund (2 per cent.) on concrete silos of the capital value of £143,000. Initial low capital cost is not therefore the main consideration in the installation of a bulk handling system. If it were, then there would be no need to introduce it, for the bag handling system involves *no* initial capital cost, but it does involve a very heavy annual one.

The opinion that it was desirable to have a scheme with a more complete mechanisation of the handling operations than provided in the experimental scheme was confirmed by the author as the result of a visit to the Eastern States as one of the party which accompanied the Hon. J. Lindsay to make personal inquiries regarding the bulk handling of export wheat in New South Wales and of millers' wheat in that State and Victoria. On his return to W.A., the Minister accepted the view expressed by the Committee. With the object of avoiding delay in Parliamentary consideration of this matter, he instructed the Committee to prepare such data as would be necessary to invite designs and tenders, to that definite information regarding costs —not estimates would be available for Parliament when it met and this subject was brought before it.*

Under these circumstances it became pertinent to ascertain what are the conditions then necessary for the introduction of such a system. Briefly, these are stated to be—

1. Facilities must be provided to receive all the farmers' wheat as under the bag system. Bulk storage on the farm of commercial grain is neither suitable nor profitable;

* Since then there has been so much organised support of the Westralian Farmers' proposal and opposition to any departure from it, that the Hon. Minister has since abandoned the idea, and also a later one to ask for a Royal Commission to investigate the features of different designs.

2. The storage facilities available must be such as to accommodate the wheat likely to be delivered by farmers, less that which the railways can transport to the mills and to the sea-board during the delivery season, and particularly during the peak periods of that season;

3. The terminal capacity must be such as to accommodate, with reasonable limits, the quantity transported by the railways during the delivery period, less the amount which is likely to be shipped during the same period;

4. Farmers must utilise the bulk handling facilities, if provided.

Experience during the past season has demonstrated that West Australian farmers are anxious to have and to use bulk handling facilities.

The table hereunder shows the elevator facilities considered necessary by the special committee appointed by the Hon. J. Lindsay, Minister for Works, in the different railway sections of the wheat districts in the Fremantle Zone:—

ESTIMATED PRODUCTION AND ELEVATOR REQUIREMENTS.

Fremantle Wheat Zone.

Railway Section.	Production		Elevator Units.	Elevator capacity. 1,000 bags.	Surplus.
	As bags. 1,000 bags.	In bulk. 1,000 bags.			
Toodyay	97	354	19	247	107
Eastern Main	37	1,399	69	897	502
Dowerin-Merredin	60	215	58	754	461
Amery, North	12	850	46	598	252
Lake Brown	66	971	57	741	230
Bullfinch-Southern Cross ...	63	63	3	39	24
Dwarda	15	...	...	...	...
Great Southern Main	97	228	9	117	111
Bruce Rock-York	56	698	36	468	230
Corrigin-Merredin	38	545	35	455	90
Narembeen	30	368	21	273	95
Brookton-Corrigin	42	183	9	117	66
Goomalling-Mullewa	...	888	47	611	277
Midland Line	No returns available				
	613	7,762	409	5,317	2,445

The above details have been very carefully prepared by Messrs. J. Hicks (District Surveyor at Northam) and J. H. Railton (District Traffic Superintendent at Northam) after a personal inspection of the localities, consideration of their productivity, and the ability of the Railways to transport the surplus.

Instructions were received to deal with each Zone as served by its respective port. A commencement was made with the Fremantle Zone as being the principal one and in which about 66 per cent. of our export wheat is produced.

The required capacity of the terminal elevator is estimated to be 1,500,000 bushels.

Summarised, the position regarding the transport facilities and proposed elevator storage is set out in the table hereunder:—

SUMMARY SHOWING PRODUCTION AND PROPOSED ELEVATOR FACILITIES.

Fremantle Zone.

	In bags.		In bulk.		Total.	
	Thousands of bags.	Per cent.	Thousands of bags.	Per cent.	Total, Thousands of bags.	Per cent.
Crop	613	7·3	7,762	92·7	8,375	100
Country elevator capacity ...	...	...	5,317	68·5	...	...
Surplus over silo capacity to be transported during harvesting period, to end of January	...	...	2,445	31·5	...	...
Transported on railways during peak period 10 weeks to end of January, 1930–31 ...	2,886	*37·2	...	...	...	...
Transported on railways during peak period 10 weeks to end of January, 1931–32	2,330	*30·0	...	...	...	...
Terminal elevator capacity ...	...	...	500	6·4	...	...
Deliveries at Fremantle to end of January, 1931 ...	2,793	*36·0	...	...	...	...
Shipments during harvesting period	2,163	*27·9	...	...	...	...
Balance stored	630	*8·1	...	...	...	...
Total elevator capacity ...	...	...	5,817	74·9	...	...

* Percentages of crop to be handled in bulk.

It will be seen from the above summary that the surplus for which no elevator storage is provided amounted to 2,445 bags, and that during the season 1930-31 the Railways transported during the peak delivery period 2,886,000 or 441,000 bags more than required during a normal harvest with storage facilities it is proposed to provide. There would thus appear to be sufficient latitude to provide that all the farmers bulk wheat can be received as delivered and that it will be unnecessary for the farmer to bulk storage on the farm for his marketable grain.

Up to the end of January during the season 1930-31, that of our record harvest, the Fremantle Harbour Trust had delivered to them 2,792,785 bags of wheat. During the same period they had shipped 2,163,307, leaving 629,478 bags in storage. Having regard to the greater rapidity with which ships can be loaded in bulk, when compared with bags, the provision for storage of bulk wheat equivalent to 500,000 bags would appear to be sufficient, and this quantity is that which the Railway Commissioner considers would meet his requirements.

One of the factors influencing the cost of storage facilities required is the size of the unit bin of the country elevator. This is determined by the minimum quantity of wheat considered necessary to justify the erection of elevator facilities at a given locality and the number of commercial types of wheat grown there.

In Western Australia, as in Australia, about 97 per cent. of our wheat conforms to the one standard known as the f.a.q., and therefore there is no necessity under our conditions for the great number of bins which apparently are required under Canadian conditions, much larger and therefore cheaper bins can be utilised.

In this connection Messrs. A. T. Brine & Sons, contractors of this city, have been of great assistance in designing first of all a bin which combines maximum capacity with durability and cheapness, and also grouping these together so as to provide convenient working facilities.

A single bin would, therefore, constitute a unit under the West Australian system, and would be erected at a siding producing 60,000 bushels of wheat, thus providing 66 per cent. storage facilities, the figure indicated by the summary as being necessary to meet the producing and transport requirements. As the producing capacity of the zone served by the siding increased, so one or more units could be added without in any way interfering with the general and completed design, a complete installation consisting of 4 units. If these are grouped in a square we then find that there are inter-spaces, the larger units being used for the f.a.q. wheat and the inter-spaces for the premium or rejected wheat, or for turning purposes.

At sidings requiring less than 4 units it is very doubtful whether provision for premium and rejected wheat is justified, but, if this be so, then smaller bins can be constructed of cribbed timber without in any way affecting the arrangement of the complete design of 4 units, and which, when these 4 units are erected, could be removed and transferred to other pioneer centres.

No provision is made for erecting storage or elevator facilities at sidings producing less than 60,000 bushels. It is considered that the requirements of these sidings can be met by providing loading directly from the farmer's wagon into the truck, as is done in Canada under similar conditions. In 1914 the Canadian Grain Commissioners reported that there were 1,600 sidings at which loading platforms were available, and that the proportion of the crop handled over them was probably one-third of the whole. This large percentage was influenced by the fact that these loading platforms were provided at sidings where elevators were erected, but farmers used the platforms to protect themselves against the practices of the elevator owners.

It is estimated that the requirements as set out in the table already referred to could be provided for by the capital sum of £1,300,000 if the whole of the silos are erected in concrete, or if some of them where similar provision is made are erected of cribbed timber the capital cost would be £1,100,000. Having regard to this, a comparison of handling in bags and in bulk is set out hereunder:—

COMPARATIVE CHARGES IN PENCE PER BUSHEL FOR HANDLING WHEAT IN BAGS AND IN BULK.

Bulk wheat if sold in bags.	d. per bus.	*Bulk wheat costs.*	d. per bus.
Acquiring and handling charges from farmer's wagon to ship, as per Royal Commission	2·772	Interest and Sinking Fund at 7 per cent. on £1,300,000	·950
Extra freight, bagged wheat (2s. 6d. 3s. 6d. per ton, 37½ bushels at 3s. 1d.)	1·000	Handling from farmer's wagon to ship, as in New South Wales ...	·800
Bags (average cost for 10 years delivered at siding, 9s. 10¾d. per dozen) ... ... 3·300		Agent's acquiring charge	·250
Less weight of bag as wheat at 3s. 4d. per bushel ... ... ·500		Reserve	·127
	2·800	Bagged wheat required for trimming	·132
Cost of twine and sewing	·500		2·259
	7·072	Advantage in favour of Bulk Handling farmer's wagon to ship ...	4·813
			7·072

The amount used as the charge for acquiring and handling wheat under the bag system is that which was given to the Farmers' Disabilities Royal Commission which inquired into the position of the Wheat Industry in 1931. Since then I understand that there has been a reduction in the price paid to agents, and also in the wages paid to lumpers. Assuming that this deduction amounts to approximately 10 per cent., say, .28 of the cost stated to the Royal Commission, the advantage to the farmer on account of bulk handling is estimated to be 4.53d. per bushel, the saving from the farmer's wagon to the ship's side, and this would be the financial benefit accruing to the farmer who did not require to purchase any sacks as is now the case with Messrs. Wilson and Chester. It is interesting to note that this amount is equivalent to the bonus on wheat paid to wheat farmers this year. The installation of bulk handling would thus be the best means of arranging for a perpetual bonus on wheat, but earned as the result of greater efficiency and not paid for out of loan money which will require to be repaid in the future.

Some farmers will require to purchase sacks as did those farmers who have been cited—Messrs. Wilson, Threlfall, and Chester. Their bag requirements were sufficient to handle 1/10th of the crop, but, as the bags will last at least two years, the ratio of bag requirements to crop is 1/20th. This on the average price of sacks is equivalent to .16 pence per bushel. In such cases it will be necessary to deduct this amount from that already stated reducing it to 4.37d. Other farmers, and these will be the extreme, will require to purchase bags for the whole of their crop, but as these bags will last for at least three years the annual expenditure for this purpose will be equivalent to bags required for 1/3rd of the crop. As the average cost of a bag is 3.3d. per bushel, this will mean a deduction of 1.1d., so that the saving on account of bulk handling to such farmers will be equivalent to 3.43d. per bushel.

The Railway Department has shown that, with the introduction of bulk handling, certain alterations will be necessary in its plant involving considerable capital outlay estimated at £320,000. The annual charge necessary to cover these alterations has been estimated at .50d. per bushel. While there is grave doubt as to whether it is proper to make such a charge against the cost of installing a bulk handling system, for such alterations are the costs which any industry has to pay for progress in that industry, some may consider the deduction should be made. When this deduction is made it will have to be deducted from the figure already given. The farmers in the best position would then benefit to the extent of 3.87d. and those in the worst position at the rate of 3.43d. per bushel.

POSSIBLE DEDUCTIONS FROM THE ADVANTAGE IN FAVOUR OF BULK HANDLING AS SET OUT IN PREVIOUS TABLE.

	d.		d.
Advantage in favour of Bulk Handling	4·81	...	4·81
Less reduced acquiring and handling costs, say, 10 per cent.	·28	...	·28
	4·53	...	4·53
Less farmer's costs for bags, as S. W. Chester, say, 5 per cent.	·16	...	...
	4·37	...	...
Less costs as in extreme case, bags for whole crop used three years	...	...	1·10
			3·43
Railway alterations	·50	...	·50
	3·87	...	2·93

In addition to the estimated financial advantage there is also the advantage to be gained as the result of the farmer being able to deal in elevator warrants instead of his actual wheat. These warrants, under a properly designed system, are regarded almost as gold currency and advances can be readily obtained up to something like 80 per cent. of their face value. It is difficult for anyone who has not been in a district where these warrants have been dealt with to realise how great their value is.

Another advantage of a properly designed bulk handling system is that the grain is controlled from the attacks of insect pests and other vermin as well as damage from weather; as may be judged by anyone who has seen the breaking-down of a stack this loss is by no means a light one.

The scheme proposed for Western Australia, whilst showing a substantial benefit to the farmer, provides for all costs to be paid by the industry and involves no burden upon the general taxpayer. In this respect it differs from the New South Wales scheme. In order to see how the proposal discussed compares with the New South Wales system the table hereunder has been prepared:—

BULK HANDLING.

A Comparison of New South Wales Installation and a Proposed Scheme for Western Australia.

Item.	New South Wales.	Western Australia—Fremantle Zone. (Department's Proposals.)
1. Capital Cost	£4,067,240 (at 31–12–31) ...	£1,300,000, all concrete; £1,100,000, composite.
2. Number of Sidings equipped	105	143.
3. Storage capacity of Silos ...	Country 16,613,000 bus. Terminal 6,750,000 ,, Total 23,363,000 ,,	Country 15,951,000 bus. Terminal 1,500,000 ,, Total 17,451,000 ,,
4. Quantity of wheat to be handled (per season)	24,330,000 bushels (1930–31)	23,000,000 bushels.
5. Elevator capacity	96 per cent	76 per cent.
6. Cost per bushel of total storage	3s. 5·7d.	1s. 6d., concrete; 1s. 3·2d., composite.
7. Cost per bushel of normal crop handled	3s. 4·2d.	1s. 1·6d., concrete; 11·5d., composite.
8. Working Expenses per bushel	0·8d. (1930–31)	Anticipated not greater than in New South Wales.
9. Interest and Sinking Fund, charged per bushel	2·81d. on 24,330,000 bushels at 7 per cent.	·950d., concrete, 7 per cent.; ·863d., composite, 7½ per cent., on 23 million bushels.
10. Charge to Grower, per bushel, through country silo for receiving, handling, and discharging into ship at Terminal	2¼d. (1930–31); 2¼d. (1931–32)	Proposed charge, 2d.

It will be seen that the systems are similar only in that both provide for the partial requirements of the respective States. The present Western Australia proposal relates only to the Fremantle Zone; this is because about 66 per cent. of the State yield is produced in the Fremantle Zone, and therefore it was considered desirable that any experience in the installation of the system should be gained

where facilities were greatest. It is, however, the intention, with Parliamentary approval, for the Minister to proceed with the installation of bulk handling in other zones as rapidly as possible. The capital cost of the present W.A. proposal is from 32 to 37 per cent. of that incurred in New South Wales. The proposed storage capacity for Western Australia is only 75 per cent. of that in New South Wales, whilst the crop to be handled in Western Australia is 94 per cent. of that which was handled in New South Wales in 1930-31.

The dominating factor in connection with the economical working is the reduced cost per bushel for the facilities provided. In New South Wales, owing to the special conditions referred to and which obtained at the time the elevators were erected, the cost per bushel capacity for the wheat handled in 1930-31 is 40.2 pence compared with the costs of 13.6 pence for all concrete construction and 11.5 pence for part concrete and part wood and concrete. These differences are consequently reflected in the annual charge necessary to cover the interest and sinking fund to cover them. In New South Wales this will be 2.81 pence per bushel and in Western Australia .950 pence for all concrete construction or .863 pence for the mixed concrete and timber.

In Western Australia the elevator capacity provided is 76 per cent. of the crop handled, and a close investigation indicates that this is sufficient to meet Western Australian requirements. In New South Wales the storage capacity to the crop handled in 1930-31 was 96 per cent. This may be reduced as the system is further extended to supplement and balance the original one, and this will naturally have a beneficial effect upon reducing the amount necessary to pay for the facilities provided.

In view of the results obtained in New South Wales and in our own State last year the question with regard to bulk handling is no longer "whether we should have bulk handling," but rather, "what form of bulk handling is the cheapest for Western Australia to adopt?" The figures which have been submitted are from very carefully compiled data and conservative estimates, and it is believed that the actual results will be slightly better than those stated. The intention of the Hon. Minister for Works is, if he can obtain Parliamentary approval, to call for designs, accompanied by firm tenders, so that the most economical design can be selected. In order to decide this question it has been suggested that it is advisable to appoint a Royal Commission or Select Committee to determine whether bulk handling is desirable or not. It is certainly necessary that Parliament should be supplied with sufficient information to enable it to decide this point, but it is difficult to understand what additional information could be made available other than that already collected, and broadcasted by the Hon. Minister for Works, who has been indefatigable in investigating this matter and collecting data from all sources. A Royal Commission or Select Committee has powers to demand information which even a State Minister may not be able to secure, but in this case there has been no need for such powers, for the information desired has been freely and willingly given.

It is, however, believed that when the designs and tenders are received a very careful investigation of the merits of each should be made in order to ensure as far as is humanly possible the very best scheme for Western Australia. It is believed that for this purpose experienced guidance should be obtained, and it is suggested the most suitable for this purpose is the experience which has been obtained under Australian conditions. It is, therefore, suggested that the General Manager and technical officers of the New South Wales elevators are suitable advisers for this purpose.

Whilst the primary object of introducing the Bulk Handling System is to reduce farmers' costs of production, it must not be forgotten that its introduction would involve the expenditure of a large amount of money for labour and materials, much of which is produced in the State and all of which is Australian. This would relieve the pressing need of providing employment on a reproductive work for many who are now without work. On completion of the system the increased spending power of the farmers, estimated at £300,000 for farmers in the Fremantle Zone, will provide additional work and absorb many, if not all, of those temporarily engaged in their construction.

The introduction of bulk handling will undoubtedly do away with the necessity for employing much of the labour now engaged in bag handling. It is unfortunate that this is so, but in this case it is believed that the labour so displaced and more will be absorbed by increased agricultural development and correlated greater activity in other branches of the industry. Expressed in another way, bulk handling will alter the character of the work, but will not reduce, and may increase its volume.

In conclusion the position with regard to Bulk Handling in Western Australia may be thus summarised:—

There are two factors which threaten the stability of our economic life; these are:—

1. Unprofitable prices for agricultural products, and
2. An unprecedented number of unemployed.

The introduction of bulk handling will have a most potent influence in remedying this unsound position. The experience already obtained with the partial installation of bulk handling in a section of the wheat area proved that those farmers who could use it reduced their costs by about 2-1/3rd pence per bushel.

Taking, however, the most extreme and most unfavourable case for bulk handling, this would be where the annual cost for the facilities provided would be equal to the cost of the bag container under the present system, *i.e.*, 3.3 pence per bushel; this annual cost is equivalent to a capital outlay of—

3s. 11.14d. per bushel for concrete elevators, or

3s. 8d. per bushel for wooden elevators.

Even under such almost impossible conditions, provided the capital outlay included the farmer's cost for transport containers, there would still be an economic advantage in favour of bulk handling in that the producer would have the benefit of cheaper handling costs due to the more complete mechanisation of the transport operations.

The work necessary to instal the required bulk handling facilities will provide employment for a large number of men during two or more years, and during a critical period of adjustment and rehabilitation.

The certain reduction in production costs, due to bulk handling, be it small or great, will place the producer on a sounder financial basis, and will, in consequence, increase his spending power and thus provide *permanent* employment for an increased number of men in many avenues of industry.

THE MARKET VALUE OF SUPERPHOSPHATE.

L. J. H. Teakle.
Plant Nutrition Officer.

As a result of the century old experiments of Liebig in Germany and of Lawes and Gilbert in England, the use of inorganic phosphate materials, as fertilisers to promote crop growth, has developed enormously throughout the world, and the world's consumption of the raw rock phosphate in 1929 amounted to 10,289,000 tons. Europe is the heaviest consumer, France, Germany and Italy alone accounting for 30 per cent. of this huge total. The United States of America is the largest individual consumer, taking about 28 per cent. of the world's production in 1928. (J. A. Bruce, "Commercial Fertilisers and their Basis of Sale," N.Z. Journ. of Agric., Vol. 43, pp. 327-337, 1931.) Australia consumed 617,485½ tons and Western Australia 182,418 tons of raw phosphate in 1928-29.

The rock phosphate is used directly as a fertiliser to a very small extent, the demand in agriculture, particularly in Australia, being for a water soluble and readily available phosphatic fertiliser. On this account the rock phosphate, as mined, is finely ground and treated with an equal weight of sulphuric acid to form the product known as "superphosphate." The phosphate in superphosphate is very largely in the water soluble form and is marketed largely on the basis of its content of water soluble phosphoric acid (P_2O_5).

The amount of phosphoric acid in the superphosphate depends on the quality of the raw materials used. This is reflected by the variety of grades of superphosphate on the market in other parts of the world. The manufactured product resulting from the treatment of the ground rock phosphate with sulphuric acid to render the phosphoric acid soluble in water is superphosphate, whether it contain 13¾ per cent. water soluble phosphoric acid or 20½ per cent. water soluble phosphoric acid (P_2O_5). It consists of a mixture of gypsum, monocalcium phosphate, small amounts of other phosphates, moisture and other substances. It may be mixed legitimately with various fillers such as sand under some circumstances.

Just as the quality of calico, or knife blades, varies according to the raw materials used and the care taken in manufacture, so the quality of superphosphate varies considerably, depending mainly on the quality of the raw rock phosphate used. As with other commodities, such as calico or knife blades, the value of superphosphate depends on the quality, and as the most important constituent of superphosphate is the plant food phosphoric acid, the basis of evaluation is the phosphoric acid content. In South Africa, for instance, superphosphates are classified as follows:—

1. Low grade—less than 15 per cent. phosphoric acid.
2. Medium grade—15.1 to 17 per cent. phosphoric acid.
3. High grade—17.1 to 19 per cent. phosphoric acid.
4. Extra high grade—above 19 per cent. phosphoric acid.

The phosphoric acid to be in a water soluble form.

The superphosphates used in England generally belong to the low or medium grades: in Australia and New Zealand only "extra high grade" superphosphate is

in use at the present time. The purity of the raw rock phosphate obtained from Nauru and Ocean Islands enables our manufacturers to place the "extra high grade" article on the market, thus saving costs in treatment at the factory and in handling in manufacturing, in transport and on the farm. It must be emphasised that "extra high grade" superphosphate can be manufactured in the ordinary way only if extra high grade raw materials are at hand.

The price paid for any line of superphosphate will be governed by the quality of the product, and the quality of superphosphate is gauged by the content of plant food; in this case phosphoric acid. Governments have undertaken supervision of the industry under various "Fertiliser Acts" which compel vendors to guarantee the composition and quality of their products. Inspections are arranged by Government officials to obtain samples for analysis in order that the composition of the lines actually delivered to the consumer may be ascertained. The Acts provide for the prosecution of vendors of fertilisers not conforming to the guaranteed standards.

Unfortunately for the layman, manufacturers and chemists in different countries have adopted different means of expression of the quality of superphosphates. For instance, in most countries the content of phosphoric acid (P_2O_5) is stated. In others, for instance South Australia, the content of tricalcium phosphate is used. Both methods of expression attain the same ends, but not without some measure of confusion. Analogies may be drawn to illustrate the point. If one wishes to drive a motor car from one city to another in Canada, United States of America, or France, one drives on the right-hand side of the road; if in England, or in Australia, one keeps to the left. This difference is very confusing at times, but traffic flows readily under either of the systems when people are used to them. A further analogy may be obtained from the grocer's shop. Suppose two grocers be advertising almonds, extra high grade, and one quotes 3s. per pound and the other 1s. 6d. per pound. At first glance one might think that grocer number one was attempting to profiteer, until it was found out that the grocer who is selling almonds at 1s. 6d. per pound is selling *unshelled* almonds and in consequence they are no cheaper than the shelled almonds which the first grocer is offering at 3s. per pound. A customer would have to buy two pounds of almonds, unshelled, from grocer number two, in order to get the equivalent of one pound of almonds from grocer number one. In the same way, the man who buys tricalcium phosphate buys phosphoric acid with the shells on, and unless he has a little chemical knowledge he does not see the shells, and gets the feeling that he is being robbed by the vendor of "phosphoric acid." This is generally not the case, as calculation to the same basis, for example, phosphoric acid, will show. As 310 lbs. of tricalcium phosphate or "phosphate" contain 142 lbs. of phosphoric acid (P_2O_5), the relation between the two can readily be seen. By means of a simple calculation, by dividing 310 by 142, it is found that, relatively, phosphoric acid (P_2O_5) is 2.184 times as valuable as tricalcium phosphate, or phosphate ($Ca_3(PO_4)_2$). If tricalcium phosphate, or "phosphate," is quoted at 2s. per unit, the value of phosphoric acid (P_2O_5) is 2s. multiplied by 2.184, equals 4s. 5d. per unit. Similarly, if phosphoric acid is quoted at 4s. 5d. per unit, the value of tricalcium phosphate or "phosphate" ($Ca_3(PO_4)_2$) is 4s. 5d. divided by 2.184, equals 2s. per unit.

Of interest is the price actually paid for phosphoric acid in different parts of the world. Prices quoted in various journals and trade papers are tabulated in Table 1.

TABLE I.

MARKET VALUE OF WATER SOLUBLE PHOSPHORIC ACID IN SUPERPHOSPHATE.
(Net Cash Value F.O.R.).

Country.	City.	Date.	Soluble phosphoric Acid.	Unit* Value.	Price per ton.
			%	s. d.	£ s. d.
England	London	6–4–32	16	3 7	2 17 0
	Liverpool	„	16	4 2	3 7 0
	London	„	13¾	3 10	2 12 0
	Liverpool	„	13¾	4 6	3 2 0
	London	15–6–31	16	3 10	3 1 0
	do.	„	13¾	4 0	2 15 0
Victoria	At Works	1932	20·5	4 5	4 10 0†
N.S.W.	do.	„	20·5	4 5	4 10 0†
S.A.	do.	„	20·6	4 5	4 10 0†
W.A.	do.	„	20·5	4 5	4 10 0†

* Calculated from water soluble phosphoric acid content. † The price for terms is £4 15s. per ton.

It should be noted that the Australian 22 per cent. superphosphates contain 0.5 per cent. citrate soluble and 1.0 per cent. acid soluble phosphoric acid in addition to the 20.5 per cent. water soluble phosphoric acid. The amounts of citrate soluble and acid soluble phosphoric acid in the English article is not stated in the journals consulted.

The net cash selling price of extra high grade superphosphate containing 20.5 per cent. water soluble phosphoric acid (P_2O_5), calculated on the basis of the unit value of the 16 per cent. P_2O_5 line, would be £3 14s. per ton in London and £4 5s. per ton in Liverpool. For the purpose of a comparison, the present prices per ton for cash f.o.r. and the unit values of "phosphoric acid" and "tricalcium phosphate" of "extra high grade" superphosphate in England and Australia are set out in Table 2.

TABLE 2.

CASH PRICES OF "EXTRA HIGH GRADE" SUPERPHOSPHATE, 1932.

Prices in London and Liverpool calculated from the Quoted Values of 16% *Superphosphate.*

Place.	Phosphoric Acid.		Tricalcium Phosphate.		Cost per ton.
	Guaranteed :	Unit Value.	Guaranteed :	Unit Value.	
	%	s. d.	%	s. d.	£ s. d.
London	20·5	3 7	45	1 7¾	3 14 0*
Liverpool	20·5	4 2	45	1 10¾	4 5 0*
Australia	20·5	4 5	45	2 0	4 10 0†

* Pounds sterling. † Pounds Australian.

At the present time, the exchange rate against Australia is approximately £25 per cent.; that is, £100 in England will cost about £125 in Australia. To buy "extra high grade" superphosphate, analysing 20.5 per cent. water soluble phosphoric acid (P_2O_5), in London and Liverpool, on the April quotations, it would cost Australians an extra £25 per cent. to cover the exchange. Neglecting the ocean freights, the costs in Australia would be as set out in Table 3.

Table 3.

CALCULATED NET CASH PRICES OF "EXTRA HIGH GRADE" SUPERPHOSPHATE IN LONDON AND LIVERPOOL, APRIL, 1932, IN TERMS OF *POUNDS AUSTRALIAN* IN COMPARISON WITH THE PRICES PAID IN AUSTRALIA.

(*Prices in London and Liverpool calculated from the Quoted Values of* 16% *Superphosphate.*)

Place.	Phosphoric Acid.		Tricalcium Phosphate.		Cost per ton, Australian.
	Guaranteed :	Unit Value, Australian.	Guaranteed :	Unit Value, Australian.	
	%	s. d.	%	s. d.	£ s. d.
London	20·5	4 6	45	2 1	4 12 6
Liverpool	20·5	5 2	45	2 4	5 6 3
Australia	20·5	4 5	45	2 0	4 10 0

From Table 3 it is seen that there is little disparity between the price of superphosphate in London and in Australia in terms of pounds Australian. If anything, on this basis, the price is in favour of Australian farmers. The Liverpool prices are distinctly higher.

As the Australian manufacturers pay exchange only on the raw materials purchased overseas, and not on the cost of manufacture other than raw material, a comparison can be made on this basis. It is calculated that the extra cost due to the rate of exchange of raw materials for the 1931-32 season amounted to 2s. 7d. per ton of superphosphate manufactured; in 1932-33 the extra cost will amount to 4s. 10d. per ton. These amounts must be deducted from the seasonal prices in order to compare them on the 1930-31 basis. Table 4 shows the trend in price of 22 per cent. superphosphate for the years 1927-28 to 1932-33.

Table 4.

NET CASH PRICES OF 22 PER CENT. SUPERPHOSPHATE IN WESTERN AUSTRALIA.

Year.	Quoted net cash price per ton.	Net cash price per ton after deducting extra charge due to exchange on raw materials.
	£ s. d.	£ s. d.
1927-28	5 2 6	5 2 6
1928-29	4 16 6	4 16 6
1929-30	4 10 0	4 10 0
1930-31	4 10 0	4 10 0
1931-32	4 10 0	4 7 5
1932-33	4 10 0	4 5 2

From Table 4 it will be seen that the net cash price of 22 per cent. superphosphate in Western Australia has not varied since 1929-30. If the extra cost due to exchange is deducted, the real price of superphosphate has actually decreased by 2s. 7d. per ton in 1931-32 and by 4s. 10d. per ton in 1932-33. Allowing for the extra cost owing to exchange on raw materials, the real cost of 22 per cent. superphosphate for the 1932-33 season is £4 5s. 2d. Australian, which is practically identical with the calculated value (£4 5s. sterling) of a similar grade of superphosphate in Liverpool.

Acknowledgment.

The author is indebted to the Director of Agriculture (Mr. Sutton) for helpful criticisms in the preparation of this paper, and to the Inspector of Fertilisers (Mr. Davenport) for assistance with regard to prices and analyses of the fertilisers.

"PINK EYE" OR OPHTHALMIA IN SHEEP.

A. McK. Clark, L.V.Sc.,
Chief Veterinary Surgeon.

This disease is caused by a germ infection of the outer covering of the eyeball and is seasonable in its occurrence. It appears generally during the summer months and is mostly associated with travelling sheep. The movement of sheep from one place to another facilitates its spread owing to its infectious character. When occurring on farms it causes a loss of condition in sheep but apart from that no other economic loss eventuates. The causal germ is carried from one sheep to another by means of flies, etc.

Symptoms.—The affected sheep will be firstly noticed in their inability to follow the mob. When being driven singly the head is held erect as if the animal is endeavouring to hear in order to discover its direction. When standing quietly the head is held low in order to avoid light. In the early stages of this disease the eye or eyes are noticed discharging water freely. On examination the eye will appear deeply injected or "blood shot." From this the name is derived —"pink eye." The eye will be noticed free from foreign bodies such as grass seeds, etc. The eye gradually becomes worse and the lids become gummy. The eyeball itself becomes opaque at a later stage. It even loses its oval shape and becomes pointed in front. It is at this stage that the animal begins to lose condition, and if affected in both eyes even runs into obstacles or water holes and becomes drowned. The disease gradually spreads to all sheep in close contact, but usually only one eye is affected.

If proper treatment is provided the sheep will gradually recover their eyesight, and spread of the disease to other sheep will be prevented. In this connection it might be as well to remind sheep-owners that it is an offence under the Stock Diseases Act to sell sheep affected with any infectious disease. The only way to avoid "Pink Eye" is to—

(1) refuse to purchase sheep from known infected flocks;

(2) examine fresh purchases and isolate them for a week, or until satisfied that they are free from disease. This is a wise procedure with all fresh purchases of live stock. If the flock is already infected remove the infected sheep into a well-shaded homestead paddock, and hand-feed and water to prevent the serious loss of condition, which will otherwise occur. The eyes of these sheep should be treated daily with the following lotion:—

Sulphate of zinc—10 grains.

Extract Belladonna—10 grains.

Water which has been boiled and allowed to cool—1 pint.

All discharges from the eyes should be removed with cotton wool, before using the eye lotion. The lotion must not be made up overstrength, or permanent damage may be caused to the eye. If unable to get the lotion made up the following lotion may be used instead:—Boracic acid, one teaspoonful, dissolve in a little hot water in a cup. Get a clean beer bottle which has previously been rinsed out with hot water, and fill to neck with warm water which has been previously boiled. then add boracic acid solution. Shake before using. Sheep which are showing an opacity or whiteness of the cornea may be treated with the following lotion:—

Silver nitrate—1 dracham.

Water which has been boiled—1 pint.

A camel hair brush or a fountain pen filler is useful to apply the lotion with, or a clean new oil can.

Every morning early the healthy sheep should be inspected to pick out the fresh cases, and these should be removed to the isolation paddock. As the sheep recover they should be put into another paddock, and not allowed to mix with the healthy sheep until all danger of infection has ceased. The sheep usually recover their sight fully and the infection will disappear in time, but the loss of condition is nearly always severe, and the amount of extra work involved in handling the flock or moving them about is often enormous.

An experiment carried out recently at the Veterinary Laboratory proved that this disease is infectious. Work is also being carried out to find out the causal organism, and if possible, to produce a vaccine which will prevent infection.

DUCK FARMING.

By A. E. Jenyns, Poultry Adviser.

With the growing interest in duck keeping, there are a few facts that intending farmers should understand. It must be remembered that there is a far more limited demand for duck eggs than hen eggs locally, and that, while there is an almost unlimited outlet overseas for the product of the hen, duck eggs are in very small demand in England. These points show that there are limits in duck farming that must not be passed if profitable returns are to be had.

THE LAYING BREEDS.

The main breeds for egg production are the Indian Runner (both fawn and white) and the Khaki-Campbell.

Of the Indian Runners the Fawn is the hardier and least nervous bird, though both Fawn and Whites are splendid layers.

The Khaki-Campbell, a breed which is becoming more popular each season, has the advantage of a larger body and quieter temperament, and is, if anything, hardier than the Runner.

Neither of these breeds of ducks appear to have any advantage over the other as egg layers. They are both, when properly handled, veritable egg machines.

TEMPERAMENT.

In breeding these types of ducks, it is always wise to remember that "haste makes waste," as they will not stand rushing about or rough impatient treatment. If frightened or unduly disturbed, they are liable to immediately retaliate by going into a moult, which means a long period of no eggs and consequently no profit. In duck farming, "temperament" is an even greater factor than with hens. The first thought in going in for ducks should be, "Am I temperamentally suited for handling nervous stock?"

The cause of many a failure can be traced to an impatient, irritable temperament in the farmer himself.

SMALL OUTLAY.

To the beginner the initial cost is very small, as housing is quite a different proposition to poultry. Small dry sheds or camping places for the cold windy seasons are all that are necessary, but for the summer months abundance of shade (natural tree shade is the best) must be provided. This, with clean, cool water, is absolutely essential if the ducks are to be kept in laying condition and health. The runs are low in cost, low fences (2 to 3 feet netting) being all that is needed. An orchard is one of the most suitable places to run ducks. They not only get the benefit of the greens and insects, but in return go a long way toward manuring the trees.

Indian Runner and Khaki-Campbells not being sitters (or non-broody), the farmer has to supply the means of incubation. On small farms a flock of muscovies are kept for this purpose, but on large holdings incubators must be used. In Western Australia it has been found that the best hatching period is from late August to November, as the weather is most suitable and the fertility better.

FEEDING FOR PROFIT.

There is a great difference between feeding and feeding for profit. Some farmers just feed anything, anyhow, and wonder why their neighbour is doing well while they are going out of business. Ducks are susceptible to sudden likes and dislikes in their feeding. The farmer will notice on feeding in the morning that, for some unknown reason, his birds won't eat; they don't like it, and unlike hens they cannot be starved into eating what they do not like. This does not necessarily mean that anything is lacking or wrong with the mixture, but often it is just that the mash is too much the same. Try making it slightly more wet or, if wet, drier, and the ducks will go back to it readily.

With correct feeding and clean water, duck eggs can be given a flavour and appearance equal to hen eggs.

Scale—by measure. 2 parts pollard, 1 bran, 3 chaffed green stuff for morning mash, mixed just damp enough to assure there is no dry pollard. By mixing it in that way it will not sour, and this enables a greater quantity to be fed at one time than the birds will eat up at once—a thing that is quite necessary where birds are

fed only twice daily. The quantity is about right if it is all cleaned up in about two hours. If there is any left at evening feed time, they are getting too much. The same applies to the evening meal, with the exception that the bran is cut out and oilcake substituted, 1½ to 2 lbs. of oilcake to 100 birds. Soak the oilcake in the quantity of water you require to mix the mash. By doing this of a morning, it is ready and well dissolved by evening. 2½ per cent. bonemeal should be added to either meal every other day, and 2½ per cent. meatmeal to breeding ducks only.

Shell grit should be always before the birds, and regular feeding is essential. Almost any kind of succulent greenstuff is good, but it is well to remember that ducks are very shy of a change, and if they are on one particular greenfeed for a long time, they do not take kindly to a sudden adoption of a new green feed. It is a good plan, where possible, to feed different greenstuff as often as possible. If this is done from the start, it makes things better and surer when they come on to lay. Laying ducks should not be let run in swamps or where they can feed on frogs, etc., as this makes the eggs not only dark in colour but coarse in flavour. Correct and clean feeding and watering is the only way to produce a well-flavoured article.

CLARIFICATION OF MUDDY WATER.

By E. S. Simpson.

Recently we received a letter from a subscriber (Mr. Daniel O'Connell, of Jandakot) supplying an excellent recipe for the clarification of some of our coastal waters. We are indebted to this gentleman for the interest he has taken in this matter, which is of more than a little importance, especially in the wheat belt, where the rainfall is less plentiful and the difficulty of water conservation in a long dry season more acute.

For the benefit of those so situated, we have obtained from the Government Chemist and Analyst, Dr. E. S. Simpson, the following note on the subject in the hope that it may prove of value to our readers:—

It is within the experience of most dwellers in the Wheat Belt that, waters which are perfectly clear and colourless, are often brackish or salt to taste, whilst really soft waters are often unpleasantly clouded with clay which refuses to settle, or which, in the case of dams, rises at the least disturbance by wind or stock. These fresh but turbid waters are perfectly safe for stock to drink, but are not desirable for household use, particularly if the clay happens to be coloured red or brown by iron oxide.

The clarification of such waters for town supplies, under the control of an engineer or chemist is usually done by filtration on large sand filters with or without the use, in strictly controlled proportions, of chemicals which, by reason of their highly astringent or even poisonous character, are not desirable on a farm or small uncontrolled country supply. These latter supplies, particularly farm dams, are easily and safely clarified by the use of a natural compound widely distributed throughout the wheat belt. This is "kopi," the very finely powdered form of gypsum, which chemically consists of sulphate of lime. This kopi is a fine white or cream-coloured powder which forms low ridges round the shores of most of our salt lakes and pans, where it often forms a favourite burrowing ground for rabbits. Thrown with a shovel over the surface of a muddy dam or other water container at the rate of 2 lbs. per thousand gallons, it will be found to coagulate and settle the mud in a few hours. It is absolutely flavorless and from a dietetic standpoint, the water will be better after the addition than before.

THE FRUIT INDUSTRY.

AREA—PRODUCTION—EXPORT.

GEO. W. WICKENS, Superintendent of Horticulture.

According to the latest figures available, which refer to season 1930/31, the area in Western Australia devoted to the production of fruit increased over that of the previous season by 285 acres, and apple orchards were again the principal factor in the increase noted, the gain in this connection being 358 acres, while the main decrease for the year occurred in vineyards—198 acres.

The principal fruits produced commercially in Western Australia are—apples, pears, oranges, stone fruits and grapes, and it is interesting to note the fluctuations that have taken place during the five years' period from 1925-26 to 1930-31. In that time the area under apple trees increased by 1,492 acres, while the areas under the other kinds of fruit mentioned all showed decreases—pears by 138 acres; oranges by 350 acres; stone fruit by 99 acres; and vineyards by 504 acres; so that apple orchards now represent 46 per cent. of the total area under fruit in the State.

Particulars giving area and production of all kinds of fruit for season 1930-31 are set out in the following table:—

FRUIT PRODUCTION AND ACREAGE FOR SEASON 1930-31.

Orchards.

Kinds of Fruit.	Area.			Yield.
	Unproductive.	Productive.	Total.	
	acres.	acres.	acres.	bushels.
Oranges	449	2,435	2,884	260,382
Mandarins	22	160	182	15,108
Lemons	53	443	496	61,605
Other citrus fruits	8	21	29	2,266
Apples	3,285	7,958	11,243	749,449
Pears	110	943	1,053	80,684
Apricots	121	545	666	43,840
Peaches	168	629	797	50,233
Nectarines	57	148	205	11,469
Plums	243	697	940	57,956
Quinces	14	78	92	7,847
Figs	47	316	363	40,270
Bananas and Plantains	2	8	10	1,075
Small Fruits	...	74	74	...
All other fruits	96	224	320	...
Totals	4,675	14,679	19,354	...
Vineyards.				cwts.
Table grapes	...	1,022	1,022	56,699
Wine grapes	...	1,136	1,136	50,133
Drying grapes	...	2,291	2,291	190,883
Not bearing vines	317	...	317	...
	317	4,449	4,766	297,715

Wine made—307,788 gallons.

DRIED FRUIT PRODUCED FROM 1930–31 SEASON'S GRAPE CROP.

	Raisins.	Sultanas.	Currants.	Total.
Cwt. Table clusters	556	4,899	34,755	47,766
Cwt. Lexias	7,556	...	...	...

During the season 1931/32 fruit, in common with all other primary products, felt the effect of world depression, but prices for apples and pears on the overseas markets did not fall in the same proportion as those for wheat and wool; and taking the season on the whole, growers of all kinds of fruit, including citrus and grapes, have experienced a fairly satisfactory season.

A record in quantity exported to overseas markets was established during 1932—831,915½ cases having been shipped to countries outside of Australia compared with the previous largest total of 737,676 cases in 1929, and though prices realised were not as high in this as in former seasons, there has been a noticeable freedom from complaint from overseas buyers concerning the condition and quality of the fruit, the vast majority of comments in this connection being favourable. London received the bulk of the shipments, 504,042 cases being consigned to that port, which, with smaller lots to Liverpool, Hull, Southampton, Manchester and Glasgow, brought the quantity sent to the United Kingdom to 67 per cent. of the total.

The quantity of fresh grapes exported was a record for the State, but prices varied considerably, those received for some of the mid-season varieties being very low, while some shipments of Ohanez made good figures. There was a good demand and payable returns were obtained for dried vine fruits in the London market in the early part of the season. 878 tons of currants and 158 tons of lexias were shipped from Western Australia before the 23rd May, and the first currants met with a fine reception.

Particulars showing quantities of fresh fruit exported and destinations are as follow:—

SHIPMENT OF FRESH FRUIT FROM WESTERN AUSTRALIA TO OVERSEAS MARKETS FOR YEAR ENDING 30TH JUNE, 1932.

Destination.	Apples.	Grapes.	Pears.	Plums.	Nectarines.	Peaches.	Oranges.	Tomatoes.	Quinces.	Lemons.
	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.
Batavia	5,767½	1,482	187½	81¼	2	...	691	...	...	146
Singapore	14,450	3,747	232½	35	5	2	2,581	...	...	304
London	429,898	30,952	40,404½	33	...	...	2,735	...	11	9
Colombo	4,086	13,035	623½	26	...	2	483	...	...	2
Bombay	156	765	...	...	...	...	...	...	...	...
Mauritius	421	235	...	...	...	...	330	...	...	30
Port Said	5.518	...	...	...	...	...	...	...	...	...
Southampton ...	620	300	...	...	...	...	...	...	...	...
Sourabaya	5,233	2,015	32	8	...	...	310	12	...	25
Samarang	380	250	...	...	...	...	...	...	...	...
Liverpool	20.537	...	...	...	...	...	...	...	...	...
Calcutta	...	100	...	...	...	...	...	...	...	...
Penang	140	40	...	...	...	...	...	...	...	...
Hamburg	115,055	...	1,628	...	...	...	20	...	...	...
Bremen	9.184	...	59	...	...	...	...	...	...	...
Glasgow	26,835	...	...	...	...	...	...	...	...	...
Hull	6,604	...	...	...	...	...	...	...	...	...
Stockholm	56,326	1,250	1,023	...	...	...	...	...	...	...
Rotterdam	19,330	...	...	...	...	...	...	...	...	...
Manchester	2,007	...	...	...	...	...	...	...	...	...
Durban	2,892	...	...	...	...	...	...	...	...	...
Auckland	...	...	...	...	...	...	30	...	...	...
Shanghai	...	...	...	...	...	...	10	...	...	2
Rangoon	50	...	...	...	...	...	25	...	...	...
Antwerp	...	...	...	...	...	...	80	...	...	...
Palembang	30	...	...	...	...	...	5	...	...	...
Total	725,519½	54,171	44,189½	183¼	7	4	7.300	12	11	518

GRAND TOTAL—831,915¼ cases.

FERMENTATION AND GRANULATION OF HONEY.

H. Willoughby Lance,
Apiculturist.

Fermentation cannot occur without the presence of yeast germs. Granulation sometimes assists fermentation and hastens it, but the yeast germs must be present in the first instance.

Yeasts are fungous germs or microscopic plants that, under suitable conditions, mutliply very rapidly. There are a large number of yeasts, but they do not all work in honey. The group that affect honey consists of what is termed the sugar tolerant yeasts; five species of this group being definitely known to cause fermentation in honey. When these little plants find conditions sufficiently favourable in the honey for growth they grow and multiply rapidly, and in growing use sugar for their food. The excretory products which are produced by the yeasts are alcohol and carbon dioxide. Analysis made of fermenting honeys shows as high as 6 per cent. by volume to be present. The carbon dioxide, being a gas, causes bubbles which give fermented honey its characteristic appearance.

For many years it was thought that fermentation was caused by what is termed unripe honey, that is to say, nectar that has been placed in the combs but has not had sufficient water evaporated from it to complete its change into ripe honey. It must be admitted that this condition is suitable for the growth of the yeast germs, but it is now been proved that it is not the cause. Yeast germs are frequently present in even ripe honey, but they do not grow as there is not sufficient moisture. Ripe honey may, however, and frequently does, especially in moist climates, ferment after it has granulated.

A Canadian student, R. M. Pugh, has shown that there is no correlation between tendency to ferment and the density of honey; nor does honey from certain floral sources ferment worse than other honey. It is merely a coincidence.

Now seeing that nectar is, as it were, the juice of the flowers, it cannot, when sucked from the nectaries of the flowers, contain yeast germs. The question, therefore, arises, How do the yeast germs obtain access to the honey? Yeasts may be present in soil, in the dust, in the air, or in the flower possibly around the nectaries; so that the bees may pick up the germs from any of these sources.

It is known that honey is a mild disinfectant, and that minute organisms that get into it accidently are usually quickly killed. One would, therefore, expect this to happen to yeast germs which may enter it. There are, however, certain conditions of honey in which the yeasts not only live, but thrive and grow in it. Some yeasts will thrive in honey with as low a water content as 9 per cent., but 20 per cent. is the most suitable for most of them.

It is well known that honey that is exposed to a moist atmosphere attracts moisture to it. It is the levulose sugar in the honey that absorbs the moisture, and it is not uncommon to find honey that has been exposed to a moist atmosphere with a thin film of watery honey on top. This is the levulose with an excess of moisture, and a suitable condition for the growth of the yeast.

There are, however, many cases where well-ripened and granulated honey ferments. When honeys granulate the dextrose forms crystals, and one molecule of water is incorporated in each crystal. These have a water content of over 9

per cent., which is locked up and becomes inactive. All water beyond the 9 per cent. in the crystals becomes part of the liquid portion, which consists of the levulose sugar, mineral and other substances, this solution forming a thin film around the dextrose crystals, and in some cases where there is an excess of this solution the excess rises to the top, leaving the crystaline portion at the bottom.

The original water of the honey in which the dextrose was formerly dissolved has been released to assist in forming the solution of levulose, sacrose, and other materials in the composition of the honey, and may result in a solution with as high a water content as 32 per cent., which is far in excess of the water content of unripe honey. This explains why ripe honey that has granulated ferments quite as frequently as unripe honey, and more frequently than honey remaining in the liquid condition.

With such a high water content as may occur in granulated honey, yeasts can thrive, and often do great damage to stored honey.

Fortunately, from general reports, we do not appear to be troubled with fermentation of honey in Western Australia to anything like the extent that they are in America. This is doubtless due to our warm dry climate. As a general rule our honey ripens quickly, and when there is a heavy honey flow on in dry weather there are many combs of uncapped but ripe honey in the hive, the bees being too busy in the field to stop to cap it.

It is, however, most important that no unripe honey should be extracted. If a hive is very full of uncapped honey, and the beekeeper wishes to extract some of this, he can usually ascertain if the honey is ripe by holding the comb at an angle and giving it a sharp shake. If none of the honey comes out, it is usually quite safe to extract. If, however, the honey is thin and some of it shakes out, the comb should be replaced in the hive.

A factor that sometimes has an influence on the growth of yeasts and fermentation is the peculiarity of honeys of different densities of not mixing readily.

It is frequently noticed that when different honeys, even extracted on the same day, are run into the settling tank, one honey goes to the bottom and the other rises to the top. In a case of this kind, if there happen to be yeast germs in the honey, it is quite likely that the thin honey at the top may ferment, especially if the tank is not carefully covered to prevent the ingress of moist air. If, therefore, it is noticed that the honeys are separating, it is advisable to at once stir and thoroughly mix the honey in the tank to bring it all to the same density; or better still, to remove it from the tank and heat it to about 150 deg. Fah., so as to prevent the growth of any yeast germs that may be present.

A high water content of honey is always liable to cause trouble with fermentation, and Fabian, of the Michigan State College, found that a water content of more than 21 per cent. was favourable to the growth of yeasts.

However, in some cases, especially with granulated honey, fermentation occurs with a comparatively low water content. Yeasts may remain dormant in honey for a long time without causing fermentation, but they begin to grow as soon as the water content of any part, especially the upper surface, is increased.

Storage in moist places, especially with high temperatures, greatly increases the absorption of moisture to the point where the density is reduced and conditions are produced suitable to the growth of the yeasts.

As has been already pointed out, granulation is no security against fermentation. From data obtained by R. M. Pugh, a Canadian student, it is shown that in America a surprisingly high percentage of honeys fermented after being kept for some months.

The heating of honey to between 150 and 160 degrees Fah. destroys the yeasts, but care must be taken that it is not heated above 160 degrees, or the colour or flavour or both may be spoilt. Even after such heating care must be taken that it is not contaminated by yeast germs, for should they enter the honey, and later it should granulate, there is the possibility of fermentation. It must, therefore, be remembered that not only should honey be well ripened before extracting, but every care must be exercised to prevent the absorption of water from the atmosphere after extracting.

Investigations have shown that much of the infection comes from the hive and its surroundings, and that yeasts also gain access to the honey from the apparatus in the extracting room, extractor pipes, tanks, etc. All apparatus and utensils that are used should, therefore, as far as possible be thoroughly cleaned with hot water and dried after each extraction, as yeast germs may be carried by these and passed on to honey that would otherwise be free from danger.

The extracting room should be kept clean and free from dust, and for this reason it must have a solid floor that can be cleansed, as provided for in the Regulations under "The Bees Act, 1930."

The question arises, What can be done with fermented honey? A good plan is to make it into vinegar, which usually sells readily; or it may be reconditioned by heating it to 150 degrees. Yeast germs are destroyed at 145 degrees. If the honey is kept at a temperature of between 150 and 160 degrees for about an hour, not only will the germs be destroyed, but some of the excess moisture will be driven off, and the scum rise to the top. It can then be skimmed and strained, and will not be liable to ferment again unless it is further contaminated.

The honey should be cooled as quickly as possible after heating to prevent loss of flavour and the darkening of the honey.

Now, as regards granulation, this was at one time a source of trouble to beekeepers, as after freshly extracted honey had been bottled and sold to storekeepers, it frequently granulated on their shelves and the public would not buy it, as the idea got abroad that such honey was adulterated. However, by reason of propaganda and education of the public, this fallacy and prejudice is rapidly disappearing, and there is now a large demand for good quality granulated honey, so much so that some large producers find it necessary to hasten granulation as much as possible.

It is generally known that honey kept in a cool place granulates more rapidly than in a hot place. Some honeys granulate much more rapidly than others, and some never granulate. Recent experiments go to show that granulation takes place more rapidly when the honey is subject to frequent changes of temperature. Also, it may not be known that liquid honey may in many cases be made to granulate much more rapidly by adding a small quantity of granulated honey to it. The smoothness and size of the granules is influenced by the quality of the added honey; thus, if honey with a coarse grain is added, there will be a tendency for all the honey to granulate with a coarse grain, whereas, if the added honey has a fine grain, the whole bulk will also have a finer grain.

The process of granulation is also hastened by stirring it every day, which also tends to make it granulate with a fine grain and with a light creamy appearance. The stirring will also bring the scum to the top, and this should be skimmed off before the honey is run into containers. This should be done as soon as the stirring has brought it to a pasty condition, as, if it is left long after it has arrived at this condition, it will set too hard to be run off.

THE FEEDING OF LIVE STOCK.

An Explanation of some of the Terms in Use.

L. C. Snook,
Agricultural Adviser.

The scientific investigator often finds difficulty in interesting the practical man in the nature of his work or the results being obtained. Not the least important reason for this is the use by the scientist of words or expressions with which the layman is not familiar. The practical farmer often has a deep-rooted antipathy to technical terms, and will not readily read articles containing them. For this reason advisory officers tend to "break down" or simplify their diction, and academic expressions are assiduously avoided.

Within limits, this practice may be sound there is no greater folly than talking "over the heads" of one's audience; but it is well to remember that scientific terms have been evolved and are used because they are concise and specific. A writer is considerably handicapped in his work when it is necessary to replace such convenient and workmanlike terms by lengthy phrases made up of more elementary words. One of the greatest advantages of education is improved facility of expression, and a well stocked vocabulary will enable a reader to take full advantage of the numerous valuable articles now available. All livestock owners are interested in feeding problems, but maybe the inability to understand only half-a-dozen terms may restrict one's reading considerably. To help remove this disability, a number of important expressions used with reference to feeding problems are explained. Knowledge of these will prove of lasting benefit.

Analyses of Foodstuffs.—The composition of a foodstuff is determined by chemical analysis. The constituents of most importance are: moisture, crude protein, soluble carbohydrate, crude fat, crude fibre, and ash.

Moisture.—It is absolutely essential to determine the moisture (water) content prior to analysis, as for purposes of comparison all results must be reduced to a dry matter basis. It is always wise to note the moisture content of a foodstuff—much expensive water is purchased as "food."

Crude Protein.—Proteins are nitrogenous compounds and constitute the most valuable (hence most expensive) part of many concentrates. During the dry summer, Western Australian pastures become deficient in digestible protein, and it is important that the acute shortage be eliminated. Until the farmer has learned to grow and store the necessary protein rich foods, it is vital that he should be able to estimate the protein value of the various concentrates now on the market. To do this, one must be able to appreciate the significance of a table of analyses.

Soluble Carbohydrates (or Nitrogen free extract).—This consists of energy or fat-producing material. The farmer grows most of the "energy" on the farm, hence consideration of this factor is not of such vital importance.

Crude Fat or Ether Extract.—This is the fraction of the foodstuff soluble in ether and consists mostly of fatty substances. The fats have more than double the "heat" or "energy" value of the carbohydrates but serve a similar purpose.

Crude Fibre.—This is the insoluble residue which remains after all the other soluble constituents have been removed. Some of this crude fibre may be broken down by fermentation in the colon of the horse or the paunch of the ruminant, but it is generally assumed to be indigestible and of no commercial value.

Ash.—This contains the various minerals originally dispersed through the foodstuff. It is only of recent years that the significance of minerals in the diet have been realised, and it is still very difficult to obtain reliable data regarding the compositions of the ash present in various foodstuffs. It is of little value to know merely the total percentage of ash present, as the constituents vary greatly. For instance, bran contains considerable ash, and hence it may be considered an excellent source of bone-building material. However, bran ash consists predominantly of phosphorous (3.3 per cent. P_2O_5; Ingle), and contains very little lime (0.3 per cent. CaO; Ingle), which is equally essential. With lucerne hay the reverse composition is seen—there may be 4½ parts of lime in lucerne ash to every 1 part of phosphorous (as P_2O_5). This explains why lucerne hay and cereal grains combine so well in a ration.

In future tables showing the composition of foodstuffs, the nature of the ash will prove a very essential section.

Digestive Co-efficient.—The value of a foodstuff depends not only on the total amount of material present, but upon the extent to which the various constituents are actually utilised by the animal. Food must be assimilated to prove of value. Careful experiments have been carried out to determine the digestibility of various foods when fed to different classes of livestock. From the data obtained, tables have been drawn up which show the number of pounds of a constituent in a given food which will be digested per 100 lb. of the constituent which is fed. These figures constitute the digestive co-efficients. An example will best show their value in practical application. In the table at the end of this article it will be seen that, when oaten grain is fed to ruminants, the digestive co-efficient for protein is 78. This means that of every 100 lbs. of protein fed in the oats, 78 lbs. will be digested. If the oats contain 10 per cent. of total protein, then the percentage of digestible protein is—

$$\frac{10}{1} \times \frac{78}{100} = 7{\cdot}8\ \%$$

The original analysis of a foodstuff by a chemist is of little practical value, as no idea of the digestibility is obtained. By use of the digestive co-efficient, a truer index of the feeding value will result.

Starch Equivalent.—Every person interested in the feeding of livestock should understand what is meant by the term "Starch Equivalent." This is a unit whereby the heat or fat-producing value of foods may be measured. Just as the value of a miscellaneous collection of articles may be compared by expressing the cost of each in some common money unit (say shillings), so also the worth of a diverse assortment of foodstuffs may be gauged per medium of the common measuring rod—the the Starch Equivalent. Also, the food requirements of various animals are known in terms of Starch Equivalent, and the most economical ration may be readily calculated.

The Starch Equivalent is the number of units of starch which have the same heating or fattening value as one hundred units of the given foodstuff. (Be careful to note that it is a measure of the energy value only—the protein and mineral content are not considered.) The starch equivalent of wheat grain may be taken as 72. This implies that 72 lbs. of starch will produce as much fat in, say, a steer as will 100 lb. of wheat. The starch equivalent for oaten grain is about 60, thus the relative fattening values of wheat and oats in this case are 72 : 60.

It is a very simple matter to work out the theoretical starch equivalent of any food of which the percentage digestible constituents are known. The method is based on the assumption that the digestible carbohydrates (including digestible fibre)

and digestible protein have a value equal to starch, and that the digestible fat is 2¼ times as valuable as carbohydrate. The starch equivalent is obtained as illustrated in the following example:—

Hay from Chapman Experiment Farm—Analysed by Western Australian Government Analyst.

	Percentage.	×	Factor.	=	Starch Equiv.
Digestible Protein	4·2	×	1	=	4·2
„ Carbohydrate ...	23·4	×	1	=	23·4
„ Fibre	22·4	×	1	=	22·4
„ Fat	1·1	×	2¼	=	2·5
			Total ...		52·5 S.E.

This signifies that 100 lbs. of the hay has the same fattening or heating value as 52.5 lbs. of starch.

The method of obtaining the starch equivalent by calculation is sometimes subject to error, as foods vary in value according to the use to which they are put. For fattening a steer, protein may not be as valuable as starch, and the factor used in multiplication should be, say, 0.9 instead of 1.0, while for milk production Halnan claims that proteins are worth 1.43 times as much as starch. Still, for the purpose of obtaining a rough guide to relative values, the factors used in the example given above are sufficiently accurate. Remember to use the *percentage digestible constituents* and not the total content as determined by original chemical analyses.

Protein Requirements.—It is not sufficient that one should know only the heating or fattening value of a food, as given by the starch equivalent. A certain proportion of protein must be present, the protein requirements varying greatly according to the purpose for which the animal is being fed. A mature beast being fattened or working will need relatively little protein, while a growing or lactating animal will require considerable quantities. Consideration of these requirements leads to the question of albuminoid or nutritive ratios.

Albuminoid or Nutritive Ratios.—Albuminoid is an old term for protein, and the albuminoid ratio is merely the ratio of digestible protein to digestible non-protein. Expressed as a fraction it appears thus:—

$$\frac{\text{Digestible Carbohydrate} + \text{Digestible Fibre} + 2\frac{1}{4}\ \text{Digestible Fat.}}{\text{Digestible Protein.}}$$

The ration may be "wide," as seen in mature hay (1 part digestible protein to 14 parts of digestible non-protein —written briefly as 1 : 14), or "narrow" as seen in skim milk (1 : 2). A narrow ration is rich in protein, while a wide ration would be poor.

Foods vary greatly in their protein content, but the needs of a given animal are restricted within certain well-defined limits. The feeding of a ration of an unsuitable nutritive ratio entails waste. For this reason farmers should endeavour to feed a balanced ration—a ration in which the ratio of protein to non-protein is adjusted to the animal's needs. The approximate nuritive ratios for various types of livestock are as follow:—

Working horses	1 : 12
Sheep	1 : 7
Beef Cattle	1 : 8
Milk production	1 : 4·5 — 5·0
Young growing animals ...	1 : 4·0
Older growing animals ...	1 : 4·5 — 6·0

It should prove an interesting and, maybe, a profitable exercise for those farmers who hand-feed pigs or dairy cows, to work out the nutritive ratio of the ration being used. The tables at the end of this article probably will supply all the requisite information.

Calculating Rations.—Nutritive ratios are useful as a means of comparing the protein contents of alternative foodstuffs, but for purposes of calculating the food requirements of various animals it is much simpler to work in terms of pounds of starch equivalent and pounds of digestible protein. The requirements of a given animal may be stated very accurately in these terms, and the sole problem is to so adjust the ration that these requirements are satisfied.

An animal requires food to maintain its bodily functions—the maintenance requirements—and food for production. It is the food consumed in excess of maintenance needs which is the source of profit. This explains the folly of underfeeding. It stands to reason that an animal will satisfy its own bodily wants before it will produce milk or wool in any quantity. The feeding of dairy cows has been reduced to a very scientific basis, and will provide an excellent example of the methods employed.

A 1,000 lb.* cow requires 6.0 lb. starch equivalent per day for maintenance. To produce one gallon of 4 per cent. milk a further 2½ lbs. of starch equivalent are required. The maintenance ration must include 0.5 lb. of digestible protein, while the 2½ lb. starch equivalent required for the gallon of milk must contain another half-pound of digestible protein.

Consider the needs of a 1,000 lb. cow yielding 3 gallons of 4 per cent. milk per day. Her requirements may be tabulated so—

	lb. Starch Equiv.	to include lb. Dig. Protein.
Maintenance	6·0	0·5
Production (3 gals.) ...	7·5	1·5
	13·5	2·0

If an analysis of the foods being utilised is available, the required ration may be worked out to a nicety. Assume that a cow has access to good green pasture and that crushed oats and good meadow hay may be fed in the bales. What is, theoretically, the correct ration to feed? The following is very close to the mark:—

	lb. Starch Equiv. including	lb. Protein.
Pasture (23lb. dry matter)	11·04	1·75
Crushed Oats (2lb.) ...	1·20	·14
Meadow Hay (4lb.) ...	1·28	·16
	13·52	2·05

It should be noted that only well managed pasture would have a value equal to 48 lbs. starch equivalent per 100 lbs. *dry weight*—this including 8 lbs. digestible protein (the figure used in the above calculation), but, nevertheless, the worth of good grazing cannot receive too much emphasis. The cows in one of the largest and best producing herds in this State receive no concentrates during the winter months, meadow hay constituting the only supplementary ration, and individual cows maintain a production of over 40 lbs. of milk per day on this economical diet. It is cheaper to fertilise pasture than to feed concentrates.

The foregoing may appear somewhat involved to an inexperienced reader, but on a second perusal much of the apparent difficulty will vanish. It is typical of human nature to shun unfamiliar things, especially where bodily or mental effort is

* An average Jersey or Guernsey cow would weigh about 850-900 lbs. when mature, while a well-developed Australian Illawarra Shorthorn cow would scale about 1,100 lbs. live-weight.

required, but do not be frightened by scientific terms—sooner or later the need for understanding them will arise. Once understood, a technical expression becomes a very useful servant. The tendency to "talk down" to the farmer should not be encouraged. On the contrary, vocabularies should be widened so as one's reading is no longer hampered by ambiguous phrases. It is hoped that this article will give a clearer understanding to several very useful expressions.

TABLE 1.

DIGESTION COEFFICIENTS—(AFTER INGLE.)

	For Ruminants.				For Pigs.			
	Protein.	Carbo-Hydrates.	Fat.	Crude Fibre.	Protein.	Carbo-Hydrates.	Fat.	Crude Fibre.
Wheat, grain	78	92	65	40	80	83	70	60
Oats	76	76	80	28	...	...	...	...
Peas	86	93	65	46	90	96	49	70
Wheat, bran	79	71	71	26	75	66	72	33
Wheat pollard	82	85	85	36	77	76	87	36
Linseed Meal	84	82	95	54	86	85	80	12
Meat Meal	93	...	98	...	97	...	86	...
Pasture, spring	75	79	66	73	...	...	...	...
Clover, before flowering	74	83	65	60	...	...	...	...
Clover, end of flowering	59	71	45	39	...	...	...	...
					For Horses.			
Meadow-hay, good	65	68	57	63	63	65	22	48
Meadow-hay, poor	50	59	49	55	55	52	29	38
Lucerne-hay early flower	76	68	46	42	73	70	14	46
Wheaten-hay	62	57	34	58	60	57	40	40
Oaten-hay	54	56	61	52	54	56	40	45
Wheaten Straw	4	37	31	50	28	28	...	18
Silage	75	67	75	61	...	...	...	...

TABLE 2.

PERCENTAGE COMPOSITION OF FOODSTUFFS—(KELLNER).

	Water.	Ash.	Digestible Constituents.				Starch Equivalent.
			Protein.	Carbo-Hydrates.	Fat.	Fibre.	
Wheat grain	13·4	1·7	10·2	63·5	1·2	0·9	72
Oats	13·3	3·1	8·0	44·8	4·0	2·6	60
Peas	14·0	2·8	19·4	49·9	1·0	2·5	70
Wheat bran	13·2	4·5	12·9	40·5	3·7	2·1	50
Wheat pollard	12·6	2·7	11·0	52·2	2·9	4·3	50
Linseed meal	11·0	6·5	28·8	25·4	7·9	4·3	72
Meat meal	10·0	6·0	40·0	...	12·5	...	62
Pasture, young	75	2·2	3·4	8·1	5·6	2·8	13·1
Pasture, mature	70	3·2	1·0	8·5	0·2	5·0	8·0
Sub. Clover (29th August)	84	1·28	3·0	6·4	0·2	1·6	11·0*
Sub. Clover (5th December)	75	1·67	2·6	9·3	0·2	2·0	10·0*
Oats, 8in. high	87	1·6	3·4	3·2	0·5	1·2	8·9
Meadow-hay, good	15	7·0	7·4	27·9	1·3	13·8	36·2
Meadow-hay, poor	14·3	5·0	3·4	19·3	0·5	15·6	18·9
Lucerne-hay, before flowering	16·0	7·3	12·1	21·1	1·1	11·3	26·5
Lucerne-hay, in flower	16·5	8·0	9·7	18·1	1·2	13·2	22·4
Wheaten-hay (Chapman)	14·38	6·75	4·2	23·4	1·1	22·4	35·5*
Oaten (in flower)	11·5	6·1	5·6	26·7	1·7	18·1	35·2
Wheaten straw	14·3	4·8	0·2	13·3	0·4	20·4	10·9
Silage (Oats)	76·3	1·8	1·1	5·9	0·4	5·1	8·9
Silage (Sub. clover)	72·0	3·23	4·2	8·9	1·0	2·7	10·0

(the S.E. of fibrous goods is much less than the calculated value because of energy "wasted" in digestion.)

(* Analyses by West Australian Government Analyst.)

APPLE POWDERY MILDEW.

GEO. W. WICKENS,
Superintendent of Horticulture.

I can well remember when Powdery Mildew was a disease of minor importance to apple growers in Western Australia, confined principally to young Northern Spy stocks in nurseries, and even there it was not much in evidence. At a later period, which, if my memory serves me rightly, was in 1907, I noticed it was showing up in a number of orchards in the South-West, that it was to be found mainly on Rome Beauty, Five Crown, and Northern Spy (three varieties fast disappearing from commercial plantations) and that though present it was not causing much damage. Since then it has spread little by little until now I doubt if there is an apple orchard in the State completely free, some being badly affected, others only in a minor degree, but taken in the aggregate the disease is causing considerable loss to the industry.

Apparently no variety is immune, but Cleopatra, Jonathan, Nickajack, and Rome Beauty are amongst the worst, while Yates and Dunns are two of the most resistant. Once the disease has obtained firm hold it is not readily controlled, and last year some growers, unfortunately, adopted measures which resulted in 50 per cent. of the Cleopatra crops being so badly marked with spray injury as to be practically unsaleable.

The spray referred to was "Iron Sulphide" (lime, sulphur and sulphate of iron), but it was not made in accordance with the prescribed formula, neither was it applied at the proper time; the latter being the main cause of the trouble, "Sulphur Sunburn" resulting after high temperatures. In the United States where Powdery Mildew is looked upon as a serious disease in apple orchards, a lot of experimental work has been carried out, and it was found that when shade temperature rose to 90°, even though a fortnight after spraying, considerable damage resulted both to fruit and foliage, and this occurred when either lime sulphur alone or iron sulphide had been applied. The orchards referred to above as being injured in this State last year were sprayed in November and December, a time when high temperatures are frequently experienced.

I think the most common method of attempts at control adopted by growers here is to incorporate a few lbs. of sulphate of iron with the lime sulphur they are using for the regular dormant spray in winter. But neither lime sulphur nor iron sulphide will control Powdery Mildew if applied while the trees are dormant. A treatment that has given partial success is the application of Atomic Sulphur at the rate of one lb. in 10 gallons of water in spring and early summer, but where the infection is severe no very tangible results have been secured.

The best results from spraying have been obtained by using iron sulphide when the blossoms are in the pink and petal fall stages, the sulphide being made by dissolving in a barrel containing 25 gallons of cold water 6 lbs. of sulphate of iron, and to this adding gradually, stirring all the time, 12 pints of commercial lime sulphur 32° Beaume. The addition of lime sulphur produces a black precipitate which settles to the bottom of the barrel, and if the liquid on top is clear, a little more lime sulphur must be added, the mixture stirred and again allowed to settle, the operation being repeated until the liquid shows a pale yellowish tint. Then the liquid (which has no value) must be drawn off and

sufficient water added to the mixture remaining in the barrel to bring it to 25 gallons, making a stock solution to be broken down to 1 in 10 before using.

This method of making sounds laborious and lengthy, but in actual practice the operator, after a few trials, knows the exact quantity of lime sulphur to add to obtain the required result and this does away with the time spent adding further small quantities, waiting for settlement, and repeated examinations of liquid.

Although this formula has been known for many years and was tried out departmentally with a large measure of success by Mr. Flintoff, Orchard Supervisor at Bridgetown, it has never been favoured by growers, the method of making apparently being considered too intricate, and the rough and ready style has been adopted of mixing sulphate of iron with the lime sulphur in the spray tank, and either applying the mixture in winter when it has no appreciable effect, or in summer when there is grave risk of causing damage to fruit and foliage.

One method of reducing infection that should receive more attention is to prune out affected shoots; these are readily descernible by their whitish appearance and malformed terminal buds, and can be removed either during the operations of winter pruning, or at any convenient time during summer or autumn.

In Bulletin No. 712 of the United States Department of Agriculture dealing with experiments made in that country, the following conclusions are given:—

"Pruning out diseased shoots cannot be depended upon alone to effect control of the disease when it is present in epidemic form," and

"The disease is readily controlled by applications of sulphur sprays during the growing season. However, after the advent of burning sunshine, the use of sulphur spray materials is certain to cause severe fruit injury."

In the same bulletin the following spraying schedule is recommended:—

"First Application—Spray with lime sulphur solution 1 to 50 when the cluster buds have separated, but before the blossoms open—the pink spray."

"Second Application—Spray with same material as soon as the petals fall and before the calyx is closed."

"Third Application—Spray with ammoniacal copper carbonate about three or four weeks after the second application."

The method of making No. 3 is as follows:—"Dissolve 5ozs. of copper carbonate in 3 pints of ammonia (25 per cent. solution which should be diluted before using). Dilute to 50 gallons in spray tank."

If the affected growths are removed from the trees, and sprays Nos. 1 and 2 are applied at the stated times, I very much doubt if No. 3 would be required in Western Australia. No. 1—pink spray—would be applied to most of our varieties in the early part of October, and No. 2 about the end of that month. This would eliminate danger from burning on account of high temperatures, and in addition to controlling Powdery Mildew would have a decidedly beneficial effect in destroying Red Mite, which at that time of the year—just emerging from the egg stage—is most susceptible.

I strongly advise apple growers whose trees are suffering from the effects of Powdery Mildew to make a test of sprays Nos. 1 and 2 in October of this year, making the experiment if only with 100 trees, so that some definite local knowledge may be gained, and if there are any who make the test, I shall esteem it a favour if they let the District Orchard Supervisor know so that the results of the work can be carefully watched and recorded for the benefit of all.

THE PRESERVATIVE TREATMENT OF FENCE POSTS.

(With Particular Reference to Western Australia.)

By J. E. CUMMINS, M.Sc., Council for Scientific and Industrial Research.

(Continued.)

8. PRACTICAL TREATMENT OF FENCE POSTS.

Preparation of Fence Posts for Treatment.—For all the preservative processes discussed, proper seasoning before treatment is essential in order to obtain good results. There are two reasons for this. Firstly, in green timber the wood cells are either completely or partially filled with sap—which is mainly water. On drying, this water is removed from the wood and thus a space is formed which can be used for the introduction later of preservative liquids. The more of this moisture removed, the more space there will be for preservatives to enter. Secondly, when wood dries, especially in the form of round posts, it usually cracks, the cracks extending some distance in from the surface. If the posts are treated before these cracks develop, then, on drying, cracks will extend through the treated area and expose untreated wood. They will therefore allow termite- and decay to gain entry to the untreated wood in the centre of the post. If the posts are first dried, these seasoning cracks are formed before treatment, and, as a result, the surfaces of each crack are thoroughly treated with preservative, and the entrance of decay or termites to the untreated wood in the centre is prevented.

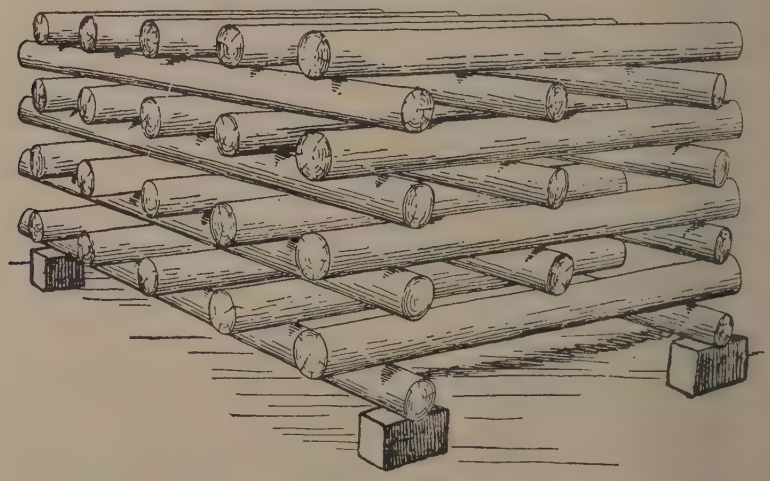


FIG. 6.—A good method of piling fence posts for seasoning.

As soon after felling as possible, the posts should be barked, care being taken to remove *all* the bark from the portion that is to be treated. In the case of *Pinus radiata* (*insignis*), a very thin inner bark often adheres very strongly to the wood. This thin inner bark often prevents penetration of the preservative, so every care should be taken to remove it from the portion to be treated. In the case of jarrah and redgum (marri), it has been found that small amounts of the inner white bark do not appear to affect the penetration but, as an added precaution, they should be removed.

For seasoning, a site should be chosen that will allow prevailing winds to blow through the stacks. For preference, the site should be on high ground, and should be well drained. In building the stack, care should be taken to have good foundations which will raise the stack about 1 foot off the ground (see Fig. 6). In cases where no suitable foundations are available, large fence posts can be used as a base. In bad termite localities, frequent inspection of the base of such a stack is necessary, because termites have been found to build their way over foundations and to attack the posts within a very short time. Provision for efficient air circulation should be made by providing a space between posts. A good method of open piling is shown in Fig. 6. Only three posts are used in each alternate layer; the other layers, with the posts at right angles to the first, have from five to ten posts. The number depends on the length and diameter of the posts, but each post in these rows must be carefully separated from its neighbour. It is sometimes possible to obtain more rapid seasoning by increasing the width of the space between posts, but if this is done in the summer time, frequent inspection of the stacks should be made to see that they are not cracking too severely. If this occurs, the posts should be placed closer together. A better method to use with timber which cracks excessively when quickly seasoned is to cut and stack the fence posts in the winter, when the drying of the timber is much slower, and there is less tendency to crack. By summer time, the timber will be partially dried and less liable to develop further cracks. Barking will also be found to be easier in the winter.

To obtain good treatment results, posts should be air-seasoned for about six months, and treated during a period of dry weather, unless arrangements can be made to stack the seasoned posts under cover in a shed. Under no condition should posts which have been recently wet by rain be treated. In the Eastern wheat belt of Western Australia, posts cut at the end of winter or in the spring should be ready for treatment at the end of summer.

Fig. 7.—A badly piled stack of fence posts. There is very little drying in such a stack, and conditions are very suitable for both decay and termite attack during storage.

The stacking of untreated posts, particularly green ones, in a close stack, as shown in Fig. 7, is bad practice, and decay or termite attack is very liable to occur before treatment.

Construction of Farm Treating Plant for Butt Treatment by the Open Tank Process.—The essential plant required consists of one or more treating tanks, the number depending on the amount of material to be treated, and a thermometer. Provision should be made for heating at least one of the tanks.

For the farm treatment of ordinary 5-ft. to 6-ft. fence posts, which are generally set to a depth of 18 inches to 22 inches, the cheapest and most easily obtained tank is the ordinary 45 gallon oil drum. These drums measure 34 inches deep by 22 inches diameter, and will permit treatment of the butt ends of the posts to a height of 2ft. 6in. Where a longer length of treated material is required, any tank which is sufficiently strong to hold the posts and solution which is free of leaks, and which can be satisfactorily heated, will be suitable.

A very satisfactory and easily-handled unit consists of four drums for treating, together with one or two extra drums for storage of solutions. The tops of the drums should be removed, and the insides wiped clean with waste cloth. Two of the drums are required to be heated and fireplaces should be constructed for

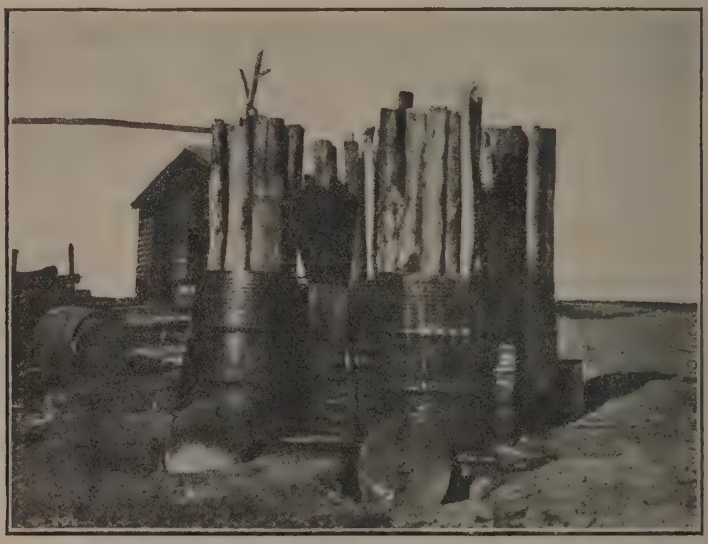


FIG. 8.—A simple fence post treating plant for use on the farm.

these. Some provision should be made for reducing loss of heat from the fire. A suitable arrangement is shown in Fig. 8. The two drums in the foreground are the heating drums, and those in the background, the cooling drums. In this case, two short lengths of old rail were used as supports, and the fireplaces were excavated slightly. The tops of the drums were used for dampers, and old pieces of galvanised roofing iron and flattened petrol tins were used for protecting the fire from the wind.

The best thermometer is a mercury thermometer reading in degrees Fahrenheit (°F.) with a temperature range up to 240°F. These cost about 3s. 6d.

If it is desired to maintain close control of the water solutions, a special hydrometer can be used (see Appendix 2).

Details of Butt Treatment Using Creosote and Oil.—The creosote and oil mixture is prepared by thoroughly mixing together *2 parts of creosote to 1 part of crude or fuel oil by volume.* For the preparation of 45 gallons of the mixture, 30 gallons of creosote should be thoroughly mixed with 15 gallons of oil. When using 3-in. to 4-in. average butt diameter posts, fill each drum to about the 18-in. mark, *i.e.*, add about 25 gallons of preservative solution. Usually, it is preferable to have a little less oil than will be actually required, as it is easier to add than to remove hot oil from the drums. For convenience, a distinct mark should be made on the outside of the drum corresponding to a height of 2ft. 6in., the length of post to be treated. The oil in the drums over the fires should be heated until a temperature of about 200°F. to 210°F. is reached. The posts should then be placed vertically in the drums, butt down, **care being taken not to splash the oil mixture into the fire.** When the drum is full of posts, the height of the preservative in the drum should correspond with the 2ft. 6in. height mark. If it does not, oil is added or taken from the drum until the required level is obtained. Heating of the drum and its contents is continued and the temperature noted. The oil should not be heated above about 210°F. as temperatures above this cause considerable loss of preservative by evaporation. When the heating period for the species being treated (see Table 1) is completed, the posts are quickly removed from the hot drum and placed in the cold drum immediately behind or alongside it. This cooling drum should contain about 1ft. 6in. depth, or about 25 gallons of solution. The heating drum can be refilled with posts and the heating continued as before. In each case, the time of the heating period is calculated from the time that all of the posts are placed in the hot oil. If the species of timber being treated requires a 4 hours' heating period, only two sets of treatments per day would probably be practicable. In this case, at the end of the heating period for the second treatment, the posts can be left in the drum and the fire drawn or allowed to burn out and the drum and its contents allowed to cool overnight. It is during the cooling period that the main part of the penetration and absorption of the preservative by the wood occurs. In the early part of the cooling, this is more rapid and the level of solution in the cooling drum and heating drum during cooling should be watched and more oil added from the storage supply to keep the oil to the 2ft. 6in. level. The posts should be removed from both drums the next morning, and the solution in the hot drums re-heated in readiness for further treatments.

With some types of creosotes it will be found after overnight cooling, particularly in cold weather, that the creosote and oil mixture in the treating drums is very thick and sticks to the posts when they are removed. This thick surface coat is an actual loss of preservative, it also makes the posts very dirty to handle, and it will run off in the stacks or sheds or wherever the treated posts may be kept until use. In such cases, the posts should not be removed until the oil has been warmed. Similarly, the posts in the cooling drums can be allowed to stand several hours longer, depending on the time of treatment being used, until they are warmed up by the surrounding air or sun, or else they can be removed from the cooling drum and dipped in the hot oil for a few minutes and then removed to the stacks.

When heating the posts in the oil, care should be taken not to use too large a fire as there will be danger of the oil boiling over. If this does happen, it is probable that the oil and posts in the treating drum will

catch fire. The rate of heating of the oil can be followed by using the thermometer at regular intervals. Approximately one hour is usually required to heat the oil alone to 210° F. using a good fire. Placing the posts in the drum cools the oil, but once the temperature is again reached, a very small fire is sufficient to keep it heated. With a little experience the fire can be easily regulated so that a minimum of attention is required.

In the instructions given above, the posts are placed in hot solution. This method has been found to be very convenient, but, if it is more practicable, the posts can be placed directly in the cold solution and heated up at the same time. If this is done, the drums will require closer watching to prevent heating above the temperature of 210° F. with the attendant danger of boiling over.

In the treatment of pine posts or the less dense hardwood timbers, it will be found that the posts float in the solution, and some difficulty is experienced in setting them upright in the drums. This can be corrected by constructing a false bottom, which can be made from the top of the drum by nailing wooden strips or riveting iron strips on one side. Screws or nails are inserted into the strips so that they protrude upwards about ½ inch to ¾ inch in height. The false bottom is placed in the bottom of the treating drum so that the projecting nails or screws point upwards.

Details of Butt Treatment, using Water Solutions.—When using the water solutions discussed below, it is advisable to erect a further drum—apart from the treating drums—for preparing solutions, particularly if large numbers of posts are to be treated. This drum should be erected over a suitable fireplace.

Zinc Chloride and White Arsenic Solution.—Zinc chloride can be purchased as a solid, which is about 100 per cent. zinc chloride, or in a solution with water containing about 50 per cent. zinc chloride.

In order to make 40 gallons of preservative solution, the 45-gallon oil-drum is filled to a height of 2ft. 2in. with cold water. A mark should be made at this height. To the water is added 14½ lb. of solid zinc chloride or the equivalent amount of the concentrated zinc chloride solution. Add 8½ lb. of white arsenic and heat the drum to boiling. Boil vigorously until all the arsenic is dissolved, which should take about 30 minutes. It will be found that the white arsenic will rise to the surface, and will be difficult to wet by stirring, but good boiling and stirring will soon dissolve it. During the boiling, water should be added to make up for evaporation, and after cooling, if the solution height is below the 40-gallon mark (2ft. 2in.), it should be made up by again adding water.*

The treatment of the posts is carried out similarly to that with creosote, except that the solution is brought to the boil and the posts boiled in the solution according to the schedules given in Table 2. As water evaporates quickly from the boiling solution, more attention is required, and water only should be added to

* To obtain the density or strength of this solution, allow it to cool, and either place the hydrometer in the solution drum or in a separate container filled with the solution. The temperature of the solution should be taken together with the reading of the hydrometer (see Appendix 2).

the treating drum to make up for the evaporation. At the end of the heating period, the posts are allowed to cool in the solution, either by remaining in the treating drum or by being quickly removed to a drum of cold solution. On cooling, absorption of solution takes place, and there is much more water solution absorbed than creosote and oil under similar conditions. To make up for the solution absorbed by the posts, fresh solution is added from the solution storage drum, so that the treating liquid is kept up to the height of 2ft. 6in. marked on the drum.

If care is taken to add *water* to the treating drum to make up for the evaporation while the posts are being boiled, and if *solution* is added during the cooling and absorption period, the strength of the treating solution will remain fairly constant. (See Appendix 2.)

White arsenic is a poison, and every care should be taken while using it. (See Appendix 3.)

Sodium Fluoride and White Arsenic Solution.

Sodium fluoride and white arsenic are both bought in powder form.

In order to make 40 gallons of solution, the 45-gallon oil-drum is filled to a height of 2ft. 2in. with cold water. A mark should be made at this height. To the water 14½ lb. of sodium fluoride and 8½ lb. of white arsenic are added. The contents of the drum should then be heated to boiling and boiled vigorously for about 30 minutes or until all the chemicals have dissolved. (See instructions for zinc chloride and white arsenic solution.)

The treatment of posts, using the sodium fluoride and white arsenic solution, is exactly the same as for the zinc chloride and white arsenic solution, and the same instructions should be followed.

Schedules of Treatment.

With the species of timber tested in Western Australia, the schedules given in Tables 1 and 2 have been found to give the best results.

Table 1.—*Schedules for the Treatment of Round Fence Posts with Creosote and Oil Mixture.*

Timber.	Time of treatment.	
	Hot bath.	Cold bath.
	hours.	
Brown Mallet	4	Overnight
Gimlet	4	,,
Goldfields Redwood	4	,,
Jarrah	3	,,
Marrie (Red Gum)	4	,,
Morrell	4	,,
Salmon Gum	4	,,
Pinus radiata (insignis)	1½	3 hours

Table 2.—Schedules for the Treatment of Round Fence Posts with Water Solutions such as Zinc Chloride with White Arsenic and Sodium Fluoride with White Arsenic.

Timber.	Time of Treatment.	
	Hot bath.	Cold bath.
	hours.	
Boree	4	Overnight
Brown Mallet	3	,,
Gimlet	4	,,
Goldfield's Redwood	4	,,
Jarrah	3	,,
Marri (Red Gum)	2	,,
Morrell	4	,,
Salmon Gum	4	,,
Pinus radiata (*insignis*)	2	,,

Top Treatment of Fence Posts.

The treatments so far outlined have been for the butts of the posts only. In the case of wood of very low durability, it is often advisable to treat completely the whole length of the post, so as to prevent any possibility of decay or insect attack above the ground. With such untreated wood, decay is particularly liable to occur at the junction of fence rails or in the holes for the wire. Complete full-length treatment is not at present economically justified under Australian conditions, since the cost of treatment is considerable. If further information is required relative to the type of plant and costs, this can be obtained by reference to the Division of Forest Products.

For *Pinus radiata* (*insignis*) it appears that a light top treatment in conjunction with the butt treatment outlined previously will be justified. This can be done after butt treatment by inserting the posts top down in a drum of hot preservative and allowing them to stand in the hot oil for about five or ten minutes. For a post longer than 5 feet there will still be an untreated length, and this should be swabbed with hot preservative several times. Alternatively, the length above the treated butt could be brush-treated with hot preservatives.

Such top treatment is of value only so long as the thin layer of treated wood is kept unbroken. If posts are checked for rails or holes made for the wires, the untreated wood so exposed should be thoroughly brushed with preservative solution, which should be applied hot wherever possible.

9.—CARE OF TREATED TIMBER.

Butt-treated fence posts, if not intended for immediate use, should be carefully open piled in a similar manner to that detailed for seasoning, except that in this case the posts may be placed somewhat closer together in the layers. If this is not done, and the posts are bulk piled on the ground, there is considerable danger of decay or termite attack developing in the untreated tops, particularly in the case of non-durable timber.

Care should also be taken to ensure that the treated area of wood is not knocked off, thus exposing untreated material. Similarly, if it is necessary to cut into the treated zone in the construction of the fence line, all untreated timber so exposed should be brush-treated several times with preservative.

In the treatment of the post, provision was made for a preserved portion to remain above ground level, and when setting the posts, care should be taken that at least 6 inches of treated wood is exposed above the surface.

10.—COST OF TREATMENT.

The cost of treatment of fence posts will vary somewhat according to local conditions and to various items which, in some cases, may be considered directly chargeable to the treatment and, in others, not chargeable. The items of material and labour are listed below, and persons considering treatment can adjust their estimates of cost according to their conditions.

1. *Cost of Untreated Posts.*

Normally, on farms requiring considerable fencing, there are areas which are to be subsequently cleared, and which carry supplies of timber which can be made suitable for fence posts. Round posts are necessary for best results, and posts from about 3 inches to 6 inches diameter will be found satisfactory for use.* Actual costs of cutting, barking, and piling for seasoning in stacks close to the falling site averaged 25s. per 100 posts (labour at 16s. per day of eight hours) for experimental work in the eastern wheat belt. With experience in cutting and barking, these costs could be reduced to about £1 per 100; and in the case of post cutting and barking, in conjunction with clearing operations, the cost should be lower again. Generally, the time of barking is about equal to the time of felling and cutting to lengths. In the case of pines, the removal of the bark is more difficult, and the average cost per 100 barked posts would be about 25s.

2. *Cost of Plant.*

Forty-five gallon oil-drums are now common articles, and are available in almost all country centres. The average cost of drums suitable for treatment is at present about 4s. to 5s. each. A treating plant, consisting of two heating drums, two cooling drums, and a solution drum, would therefore cost about £1. The fireplaces can generally be made from old iron, bricks, or stones, and to make them should not occupy more than an hour or two.

3. *Cost of Preservatives.*

The cost of preservatives varies somewhat according to market prices. The prices quoted hereunder are approximate only, and for Western Australia freight rates, as per Table 3, must be added to them.

Creosote.—Creosote varies considerably in price according to its grade and source of supply. A good grade creosote for wood-preserving purposes would cost about 1s. 9d. per gallon, f.o.r. Perth, in 45-gallon containers.

Fuel Oil.—Fuel oil can be obtained at 5d. per gallon, f.o.r. Fremantle, in 45-gallon drums. The drums are returnable, but are charged for at the rate of 5s. each. They would be suitable for treating drums.

Sodium Fluoride.—Sodium flouride in solid form will cost about 5d. per lb., f.o.r. Perth, in cwt. lots.

Zinc Chloride.—Zinc chloride in 50 to 55 per cent. solution will cost 3½d. per lb., f.o.r. Perth, in cwt. lots. It must be remembered that this solution only contains about half its weight of zinc chloride, so that the cost of the solution at the farm should be multipled by two to give the approximate cost of the pure zinc chloride.

White Arsenic.—The price of white arsenic is about 5d. per lb., f.o.r. Perth, in cwt. lots.

* If split posts are treated only the sapwood will be well penetrated. While, therefore, the treatment will not be as effective as with round posts, where the latter are unavailable, it will probably be justified.

Table 3.—Freight Rates on Preservatives, Western Australia.

Preservative.	Freight Rate. (Small quantities.)		
	100 miles.	200 miles.	300 miles.
Creosote	Per 45-gal. drum—about 10s.	Per 45-gal. drum—about 15s.	Per 45-gal. drum—about £1.
Crude Oil	Per 45-gal. drum—about 10s.	Per 45-gal. drum—about 15s.	Per 45-gal. drum—about £1.
Sodium fluoride ...	3s. 9d. per cwt.	5s. 6d. per cwt.	7s. 6d. per cwt.
Zinc chloride	5s. 6d. per cwt.	8s. 9d. per cwt.	12s. per cwt.
White arsenic	4s. 6d. per cwt.	7s. 6d. per cwt.	10s. per cwt.

Fuel.—The only charge for fuel on most farms will be the cost of collection. For two 4-hour boiling periods in the one day and the same drum, using water solutions, the amount of wood required would be, approximately, 1 cwt. to 1¼ cwt. For similar oil treatments the quantity would be considerably less. With firewood estimated at 6s. per ton for collection and cartage to the treating site the cost per day per two 4-hour treatments is about 4d. to 5d.

Labour.—The cost of labour for the treatment of fence posts as outlined above is difficult to estimate. Fence post treatment does not require continuous supervision. Once the solution has been heated, the posts inserted, and the correct treating temperature reached, only occasional firing and adjustment of solution levels is necessary. On a farm, therefore, a man treating posts can be doing other odd jobs at the same time. Also, it is possible that treating can be carried out at times when conditions are unsuitable for general farm work. If labour is employed continuously on fence post work, then the size of the treatment plant should be enlarged so that the labour cost per post is low.

11. ESTIMATED COST OF TREATED FENCE POSTS.

The cost of a treated fence post depends primarily on the cost of the untreated post, the cost of preservative and the amount of it absorbed by the post, the output of the plant and labour. In Tables 4 and 5 the estimated costs of treatment of posts of an average butt diameter of 4 inches are given. The times of treatment are based on those Tables 1 and 2, and it is assumed that there is a total of four drums for treatments.

A study of the tables shows that for treatment with creosote and fuel oil the items making up the cost of treatment are distributed in the order: Cost of preservative, cost of untreated posts, and labour. Where large numbers of posts are to be treated the cost of labour per 100 posts can be considerably lowered by increasing the number of treating drums.

In the case of treatment with water-soluble preservatives, the items making up the cost of treatment are distributed in the order: cost of untreated posts, labour, and cost of preservatives. Treatment with water-soluble preservatives costs less than with creosote and oil. Offset against the lower cost of treatment, however, is the fact that creosote and oil-treated posts will generally give longer life than posts treated with water-soluble preservatives, the latter materials being liable to be washed out of the wood by rain, drainage water, etc.

Table 4.—Estimated Cost of Treating with Creosote and Fuel Oil 100 Fence Posts, Average Butt diameter 4 Inches, Adding Freight for 200 Miles to Cost of Chemicals Used, and Using Four Drums for Treatments.

Species.	Average absorption per cubic foot of length treated.	Absorption of preservative per 100 posts.	Time of treatment.	Cost of barked untreated Costs.	Cost of preservatives absorbed.	Cost of treated posts excluding labour.*
	lb.	lb.	days.	£ s. d.	£ s. d.	£ s. d.
Brown Mallet	7·5	163·5	2	1 0 0	1 7 1	2 7 1
Gimlet	7·0	152·6	2	1 0 0	1 5 3	2 5 3
Goldfield's Redwood ...	5·0	109	2	1 0 0	0 18 1	1 18 1
Jarrah	6·0	130·8	1½	1 0 0	1 1 8	2 1 8
Marri (Red Gum) ...	7·0	152·6	2	1 0 0	1 5 3	2 5 3
Morrell	9·0	196·2	2	1 0 0	1 12 6	2 12 6
Salmon Gum	6·0	130·8	2	1 0 0	1 1 8	2 1 8
Pinus radiata	9·0	196·2	1	1 5 0	1 12 6	2 17 6

* NOTE.—When treatment can be carried out under favourable conditions and only the actual time of working on the treatment is chargeable, the estimated cost of labour at £3 15s. per week for brown mallet, gimlet, Goldfield's redwood, marri, morrell and salmon gum would be about 18s. per 100 posts, for jarrah about 14s. and *Pinus radiata* 10s. per 100. A small charge for firewood of about 1s. to 1s. 6d. per 100 posts and any minor items should be added to the cost given under "Costs of treated posts."

Table 5.—Estimated Cost of Treating with Water-soluble Preservatives 100 Fence Posts, Average Butt Diameter 4 Inches, Adding Freight for 200 Miles to Cost of Chemicals Used, and Using Four Drums for Treatments.

Species.	Average absorption of solution per cubic foot of length treated.	Absorption of solution per 100 posts.	Time of treatment.	Cost of barked untreated posts.	Cost of preservatives absorbed.		Cost of treated posts excluding labour.*	
					Sodium fluoride and white arsenic.	Zinc chloride and white arsenic.	Sodium fluoride with white arsenic.	Zinc chloride with white arsenic.
	lb.	lb.	days.	£ s. d.	s. d.	s. d.	£ s. d.	£ s. d.
Brown Mallet ...	12	262	1½	1 0 0	6 10	9 3	1 6 10	1 9 3
Gimlet ...	9	196	2	1 0 0	5 1	7 0	1 5 1	1 7 0
Goldfield's Redwood ...	8·5	185	2	1 0 0	4 10	6 7	1 4 10	1 6 7
Jarrah	11	240	1½	1 0 0	6 3	8 6	1 6 3	1 8 6
Marri (Red Gum)	13	283	1	1 0 0	7 4	10 0	1 7 4	1 10 0
Morrell	12	262	2	1 0 0	6 10	9 3	1 6 10	1 9 3
Salmon Gum ...	10	218	2	1 0 0	5 8	7 9	1 5 8	1 7 9
Pinus radiata ...	11	240	1	1 5 0	6 3	8 6	1 11 3	1 13 6
Boree	7	153	2	1 0 0	4 0	5 5	1 4 0	1 5 5

* NOTE.—When treatment can be carried out under favourable conditions and only the actual time of working on the treatment is chargeable, the estimated cost of labour at £3 15s. per week for gimlet, Goldfield's redwood, morrell, salmon gum and boree would be about 18s. per 100 posts, for mallet and jarrah and about 14s. per 100 posts, and marri and *Pinus radiata* about 10s. per 100 posts. A small charge for firewood of about 1s. to 1s. 6d. per 100 posts, a charge for carting water to the treating plant, and any minor items should be added to the cost given under "Costs of treated posts."

However, in the Eastern wheat belt, in rainfall areas below about 18 inches per annum, the factor of leaching becomes less important and the use of water-soluble preservative is recommended.

The estimates given in Tables 4 and 5 are a guide only, and in estimating his own costs a farmer should make allowance for the actual cost to him of preservatives, untreated fence posts, and labour. If only a small number of posts are being treated, the total or a large proportion of the cost of the treating plant should be debited against the cost of the treatment. At the conclusion of the treatment there will remain on hand quantities of preservative solutions, which will be found to be of considerable value for brush-treating shed posts, gates, and other farm structures.

12. PROBABLE LIFE OF TREATED FENCE POSTS.

No data are available regarding the life of treated fence posts for the species of timber available for treatment in Western Australia. Experience with preserved fence posts in other countries, however, shows that properly-creosoted posts will give a life of at least 20 to 25 years. In dry localities, posts treated with water-soluble preservatives should give a life closely approximating this.

In conjunction with the Western Australian Forests Department, about 1,800 fence posts were treated with preservatives as set out in this publication. These posts have been installed in fence lines in three different localities in Western Australia, viz., Ghooli (near Southern Cross), Wickepin, and Pemberton. Frequent inspections of these lines will be made, and when the information is available details of results being obtained will be widely published in agricultural papers.

13. ECONOMY OF TREATMENT.

Although it is possible to increase the life of timber by preservative treatment, it is not economical to do so unless the cost of treatment is more than repaid by the increase in the life of the post. The cost for setting an untreated post is the same as for a treated post. If a treated post will last twice as long as an untreated one, then to the increased life of the treated post must also be added the cost that would have to be borne if the untreated post was removed and a new one put in its place. The best method of comparison therefore is to determine the annual service charge (cost per year of life) as distributed over the length of life of the post, assuming a constant charge for setting, compound interest at, say, 5 per cent. per annum, and no value for the eventually destroyed fence post. The costs per year of life of a post costing one shilling in place are given in Table 6.

Table 6.—Costs per Year of Life Posts Costing 1s. in Place. Compound Interest at 5 per cent.

Life in Years.	Annual Service Charge.	Life in Years.	Annual Service Charge.	Life in Years.	Annual Service Charge.
	s.		s.		s.
1	1·050	11	0·121	21	0·078
2	0·538	12	0·113	22	0·076
3	0·367	13	0·107	23	0·074
4	0·282	14	0·101	24	0·073
5	0·231	15	0·097	25	0·071
6	0·197	16	0·092	26	0·070
7	0·173	17	0·089	27	0·069
8	0·155	18	0·086	28	0·076
9	0·141	19	0·083	29	0·066
10	0·130	20	0·080	30	0·065

From Table 6, the cost per year of life for a post which cost 1s. 6d. to set, and which lasted ten years, would be 0.130 multiplied by 1½ equals 0.195 shillings, or about 2⅓d.

The following figures give an indication of the method for determining the economical value of treatment. The details of working are given in Appendix 4.

1. (a) For an untreated salmon gum post costing 2d. to cut and 1s. to set, and lasting seven years, the cost per year of life would be 0.202 shillings, or about 2½d.

(b) For a salmon gum post treated with creosote and fuel oil at a cost of 8d., plus 1s. to set, and lasting 20 years, the cost per year of life would be 0.133 shillings, or about 1½d.

(c) For a salmon gum post treated with sodium fluoride and white arsenic at a cost of 6d., plus 1s. to set, and lasting fifteen years, the cost per year of life would be 0.145 shillings, or about 1¾d.

The above figures show that both creosote with oil, and sodium fluoride with white arsenic treatments would result in a considerable saving over the use of untreated posts. For one post, this does not seem large, but if the results are considered for 1,000 posts the saving would be £3 9s. per year when using creosote with fuel oil, and £2 15s. per year when using sodium fluoride with white arsenic.

2. If a durable post costing 1s. on the farm, plus 1s. to set, lasts 30 years, the annual service charge would be 0.130 shillings. Creosote and oil-treated salmon gum posts, lasting 20 years, would have a cost per year of life of 0.133 shillings (see above). The difference is very small, and on account of the lower actual immediate outlay in money (£5 per 100 for naturally durable posts as against about £2 5s. per 100 for creosote and oil-treated salmon gum) the ordinary farmer would probably consider the treated salmon gum post as being the better for his purpose.

By estimating his own costs of treatment, by determining the probable cost per year of life on his posts, and by considering his initial outlay, a farmer can make his own decision on the advisability of treating and on the type of treatment.

14. CONCLUSIONS.

The preservative treatment of fence posts means, in a large number of cases, a saving in first cost together with, in many cases, a reduced cost per year of life. It also makes available for use large quantities of timber which would otherwise be destroyed in clearing operations.

Three different types of preservatives are described for use with the open tank process and the choice of any one will depend on the cost, the availability of supplies, the location of use, and the estimated life or annual service charge. Creosote with fuel oils is better for use in wetter localities and treatment with this type of preservative is generally easier and simpler than with water-soluble preservatives. Either of the two types of water-soluble preservatives, *i.e.*, sodium fluoride with white arsenic or zinc chloride with white arsenic will give good service in drier localities, and the choice of these latter preservatives is a question of price and availability.

If information on source of supplies is required, inquiries should be addressed to the Conservator of Forests, Forests Department, Perth, or the Chief, Division of Forest Products, 314 Albert-street, East Melbourne.

The practice of preservation can likewise be extended to farm timbers other than fence posts, and the Division of Forest Products will gladly advise and assist farmers or other users of timber.

The Division would be grateful if those who have adopted the methods of treatment of this publication would forward details of the quantity and kind of posts treated, and of the preservatives used. This information will be of value in future years as a record of the advantages to be gained by preservative treatment.

APPENDIX 1.

Creosote Oil.

In this appendix, full details are given regarding the quality of creosote oil suitable for fence post treatments. If a user of oil is in doubt as to whether a grade of oil offered for sale is suitable he should state on his order that it must comply with the specification given below. It should not be necessary to do more than refer to this publication which will be forwarded to all known creosote producers in Australia.

In England, Europe, and the United States of America, creosote oils mostly used for wood preservation are horizontal retort oils and any such creosote oil conforming to the British Engineering Standards Association specification No. 144, 1921, or grades 1 and 2 of the American Wood Preservers' Association, is satisfactory for fence posts.

The bulk of Australian creosotes are produced from vertical retorts and they differ considerably from the horizontal retort oils. An investigation is now being undertaken to determine suitable specifications for these oils. Pending the completion of this, a tentative specification compiled from the results of the investigation to date, together with information collected from England, the United States of America, and New Zealand is suggested for use. This tentative specification is, of course, subject to modification after completion of the work. Vertical retort creosotes bought according to this specification should give complete satisfaction as fence post preservatives.

Tentative Specification for Australian Creosote Oils for Fence Post Preservation.

1. The oil shall be a distillate of coal tar and be free of any admixture of petroleum or similar oils. (In the case of ready-prepared creosote with oil mixtures the creosote used shall conform to the specification, and be in the proportion of at least 2 parts of creosote to 1 part of petroleum oil.)

2. The specific gravity of the oil at 38°C. compared with water at 15.5°C. shall be not less than 0.94.

3. The oil shall not contain more than 3 per cent. of water.

4. The oil shall not contain more than 0.5 per cent. of matter insoluble in benzol.

5. The distillate based on water-free oil shall be within the following limits:—

Up to 210°C. not more than 10 per cent.
Up to 235°C. not more than 35 per cent.
Up to 315°C. not more than 85 per cent.

6. The residue above 355°C. if it exceeds 5 per cent. shall have a float test of not more than 50 seconds at 70°C.

7. The amount of tar acids shall be not less than 5 per cent. by volume. There shall be no upper limit to the amount of tar acids.

The foregoing tests shall be made in accordance with the standard methods of the American Wood Preservers' Association. (Details of these methods will be supplied on application.)

APPENDIX 2.

Method of Controlling the Strength of Water Solutions.

It is very desirable that the strength of the treating solutions should be controlled. This can easily and conveniently be done by the use of a hydrometer, which is an instrument for determining the density or strength of solutions. A type recommended for use with the solutions of sodium fluoride with white arsenic and zinc chloride with white arsenic for the open tank process is one marked from 1,000 to 1,060, costing about 3s. 6d. to 4s. 6d. In use, it is simply placed in a long glass or tin of solution, and the point at which the liquid and the scale-marking coincide is noted. It will be found that the solution will be raised slightly around the glass stem of the hydrometer. The reading should be taken at the top of the raised surface against the hydrometer stem.

When using the hydrometer, the following simple precautions should be taken:—

1. The stem should be dry when it is used and it should be carefully inserted into the liquid so that the stem is not wet excessively.
2. The hydrometer should float freely in the solution and should not be in contact with the sides of the vessel when the reading is taken.
3. After use the hydrometer should be rinsed in clean water and dried.

As explained on page 24 the strength of the treating solutions can be roughly regulated by ensuring that during the boiling period, *water* is added to make up loss by evaporation, and during the cooling period, *solution* to make up for that absorbed by the posts. It is desirable that a closer control of the strength than is possible by this method is used. This can be very simply and conveniently done by using a hydrometer and a Fahrenheit thermometer.

When the fresh solution is prepared, a sample should be removed in a convenient vessel, allowed to cool, and the hydrometer reading taken together with the temperature. Whenever the strength of the treating solution is again determined, care should be taken that the temperature is not more than 5° Fahrenheit above or below that of the temperature of the fresh solution, as a larger difference in temperature affects the reading on the hydrometer. The strength of the fresh solution should be carefully recorded, as it is to be used for comparison with the treating solutions in use.

The strength of the fresh zinc chloride and white arsenic solution should be about 1050 at 60°F., 1049 at 70°F., and 1047 at 80°F., while the fresh sodium fluoride and white arsenic solution should be about 1053 at 60°F., 1051 at 70°F., and 1050 at 80°F. Commercial hydrometers vary somewhat, and it may be found that the strengths of the fresh solutions will differ from the figures given above by one to three points. Provided however, that the reading is carefully taken, the actual figure obtained does not matter.

If the treating solution is becoming weaker, it will be found that the hydrometer reading will be less than that for the fresh solution. For every point difference, one-half gallon of solution should be added during the **boiling period** to the treating drum (containing 25 gallons) to make up for some of the evaporation. For example, if the strength of the fresh solution at 70°F. is found to be 1049, and the strength of the solution being tested is 1043 at the same temperature, then the difference in the hydrometer readings is 6. Therefore, in order to increase the strength of the treating solution to normal, 6 multiplied by one-half, i.e., 3 gallons of solution, should be added to the 25 gallons of solution in the treating drum during the boiling period. The same method applies, whether the zinc chloride with white arsenic or sodium fluoride with white arsenic solutions are used.

If the strength of the treating solution becomes greater than that of the fresh solution it can be corrected by adding water directly to the treating drum. If the level in the treating drum is correct, a better way is to remove solution and replace it by water. For each point of the hydrometer reading greater than the recorded reading of the fresh solution, remove half-a-gallon of solution and replace it by half-a-gallon of water.

A kerosene or petrol tin holds 4 gallons of water or solution, and is a convenient measure for use. If the height of the tin is divided into eight equal parts, and these are clearly marked on the outside, each mark will represent, approximately, half-a-gallon of solution.

Tests of the strength of the water treating solutions should be made, if treatment is continuous, at least twice a week. More frequent determinations will give closer control of the strength of the solutions, but, if care is taken to follow the directions given, these are not thought to be necessary.

APPENDIX 3.

Precautions when using White Arsenic.

White arsenic is a poison, and care should be taken while using it. On no account should the powder or the solution be kept near food of any description. The precaution of thoroughly washing the hands after handling the solution or treated posts before handling food will prevent any trouble. If sores, open cuts, or abrasions are on the operator's hands, they should be kept well bandaged and out of contact with solution, as festering is likely to occur.

If by accident the white arsenic solution or powder is swallowed, vomiting should be brought about by taking a glass full of lukewarm water containing one tablespoon of salt or a dessert spoonful of mustard, or by tickling the throat with a feather. Drinks of milk, raw eggs and milk, olive oil, or strong tea should be taken afterwards. If necessary medical advice should be obtained.

APPENDIX 4.

Economy of Treatment—Details of Calculations.

The figures in Table 6, giving the cost per year of life of posts costing 1s. in place, compound interest at 5 per cent., were obtained from the formula—

$$\text{Cost per year of life} = \frac{CR\ (1+R)^n}{(1+R)^n - 1}$$

where C = final cost of post in place,
R = rate of interest (5 per cent. = 0.05),
n = life of posts in years.

By using this formula, the figures in Table 6 can be extended beyond the period of 30 years if so desired.

Details of working—	s.	d.	
1. (a) Cost of cutting salmon gum post	0	2	
Cost of setting	1	0	
Total cost of untreated post in fence	1	2	
Estimated life of untreated post			7 years.
Cost per year of life = 0.173 (from Table 6) multiplied by 1⅛ shillings = 0.202 shillings, or about 2½d.			
(b) Cost of cutting, seasoning, and treating salmon gum post with creosote and fuel oil	0	8	
Cost of setting	1	0	
Total cost of treated post in fence	1	8	
Estimated life of treated post			20 years.
Cost per year of life = 0.080 (from Table 6) multiplied by 1⅔ shillings = 0.133 shillings, or about 1½d.			
(c) Cost of cutting, seasoning, and treating salmon gum post with sodium fluoride and white arsenic	0	6	
Cost of setting	1	0	
Total cost of treated post in fence	1	6	
Cost per year of life = 0.097 (from Table 6) multiplied by 1½ shillings = 0.145 shillings, or about 1¾d.			
2. Cost of durable post	1	0	
Cost of setting	1	0	
Total cost of durable post in fence	2	0	
Estimated life of durable post			30 years.
Cost per year of life = 0.065 (from Table 6) multiplied by 2 shillings = 0.130 shillings or about 1½d.			

HOME FELLMONGERING METHODS.

HOW TO REMOVE THE WOOL.

Hugh McCallum.

The cleaning of the wool from sheepskins is known as "fellmongering."

Dry skins are those taken off the sheep carcase, and then dried and stored. Green skins are those from freshly slaughtered sheep. "Pelt" is the name given to the skin after the wool has been pulled or taken off. "Slipe" is the pulled wool that has been dried and not scoured. "Skin wool" is pulled wool which has been scoured and dried. "Plucked wool" is that plucked from a sheep that has been dead for a few days. "Fallen" or "dead" wool is that taken off the remains of a sheep which have been dead for a considerable time.

Fellmongering is usually undertaken by a special firm, and the object is to remove all wool from the skins, leaving the pelt uninjured and the wool in its natural state. The firms undertaking this work have special processes, one of which includes the use of lime, but these might not prove satisfactory at the hands of an amateur. For farm or station use the general procedure is:—

(a) Soften the skins by soaking;
(b) Sweat the skins to loosen the wool;
(c) Pull or push off the wool;
(d) Dry the wool;
(e) Stretch and dry skins, and tan if required.

Skins should be prepared by cutting off feet, face skin, hocks and ears, as these portions tend to heat quicker than the balance of the skin and may blacken in the sweating. They will quickly discolour other wool with which they may have come in contact.

Skins should be soaked until well softened, probably one to three days, then drained for about twelve hours.

They are then spread out on a flat piece of ground or shed floor, which has been covered with bagging, taking care to turn the skirts and points under so that they attract the heat sooner than the outside parts; pack skins one on top of the other, then cover with bags or sheets to keep the warm moist air in and prevent and cold air penetrating the heap. In warm, close weather, the skins will require to be reversed after sweating from 16 to 20 hours, but in cold weather they may require up to two days.

Examine from time to time, taking care not to permit too much cold air to reach the heap, and test for loosening of the wool. As the wool commences to leave the skin, take each skin out and spread on a log or board, and pull or push off the wool, using a blunt instrument. Clean boards or bags should be spread round and the wool placed on same. The wool from the back, sides, and shoulders should be first removed and placed in a separate heap, being classed as "firsts"; the edges of the skin are next treated, and the wool classed as "seconds" are short; bitty trimmings are then removed and put into "thirds."

The wool must not be permitted to remain in heaps for, being wet, it will soon heat.

If it is not intended to scour it immediately, it must be spread out on bags or wire racks to dry. When thoroughly dried the wool can be pressed and bailed.

If the skins are required for use, they should be stretched out to dry, the same as when taken off green, and they can afterwards be tanned and used for many odd purposes on the farm.

DROOPING FLOWERED CLOVER SEED.

G. R. W. Meadly, B.Sc., Agricultural Adviser.

Drooping Flowered Clover (*Trifolium cernuum*) is native to Spain and the Mediterranean Region, and according to old residents has been known to occur in Western Australia for at least twenty-five years. It was originally noted at Gingin, hence the early name of "Gingin Clover," and has now become one of our most important clovers, being widely distributed throughout the South-West, South Coastal, and Great Southern Districts.

As it is not grown to any extent in the other States, farmers are dependent upon locally-produced seed, which largely comes from the Harvey, Boyanup, Busselton, and Capel districts. The production last year was in the vicinity of 7,500 lbs., with an approximate value of £1,000, but unfortunately during that season the "hard seed" content of the clover was phenomenally high.

The majority of leguminous plants produce a certain number of so-called "hard seeds" which are viable, but do not readily germinate. After the germination of the normal seeds these "hard seeds" produce seedlings at intervals, and some may still be viable yet not germinated after a period of years. This feature is of most importance locally in connection with Lupins, Subterranean, Cluster, and Drooping Flowered Clovers.

Under certain circumstances "hard seeds" must be regarded as an asset, for once an annual clover is established, their presence, to a reasonable extent, is of value for ensuring a stand each year. Early rains followed by a dry period may germinate the ordinary seeds produced by the seeding down of the previous year's crop, only to kill most of the young seedlings. Under such circumstances some of the "hard seeds," the germination of which has been retarded, produce at a more seasonable period seedlings which comprise entirely, or increase considerably, the stand of the clover.

At the time of original planting, however, when the actual date of sowing can be regulated to suit the conditions prevailing that season, the presence of a large percentage of "hard seeds" must be considered detrimental, at least for the first season's crop.

The following table gives the purity, germination, and "hard seed" content for Drooping Flowered Clover during the last three years:—

Year.	Pure Seeds.	Impurities.	Weed Seeds.	Germination.	Hard Seeds.
	%	%	%	%	%
1929–30	69·2	23·3	7·4	31	66
1930–31	79·0	12·4	8·6	39	60
1931–32	90·8	6·2	2·3	6	94

The purity of the seed produced has improved from year to year, but, as mentioned previously, the germination in 1931-32 was very low, due to the high percentage of "hard seeds" which was probably caused by the unusually dry conditions existing during the ripening period. Fortunately, by scarifying this type of seed the germination can be increased considerably. Experiments recorded in the June issue of this Journal show that by means of the scarifying machine employed, seed of Drooping Flowered Clover normally giving a germination of under 1 per cent. may have its germination raised to above 40 per cent.

When purchasing seed an important phase, apart from the germination, is the purity, particularly the absence of serious weed seeds. In one line of Drooping Flowered Clover seed tested the impurity figure was 57.6 per cent., and 47.6 per cent. of the total weight was composed of sand. As this line also contained 2.8 per cent. weed seeds, and gave a germination of 23 per cent., its actual value was very low. The foreign seeds present may be conveniently classed into two groups, weed seeds, *e.g.*, Sorrell, Flatweed, and other crop seeds, *e.g.*, Cluster Clover, Rye Grass.

The following are notes on Drooping Flowered Clover and its main seed impurities:—

Drooping Flowered Clover (*Trifolium cernuum*).—This is one of the most important annual clovers in this State, and is particularly suited to ground which retains its moisture well into the summer. It will withstand considerable inundation during the winter months, and hence will grow in much wetter situations than Subterranean Clover.

The seed is yellow and very small, being about 1.3 mm. long by 1 mm. wide (Fig. 1), and one pound contains approximately 1,300,000 seeds. Drooping Flowered Clover should be planted in autumn, and sown at the rate of 4 lbs. per acre if of average purity and germination. When sown in mixtures the amount depends upon the other constituents of the mixture.

Cluster Clover (*Trifolium glomeratum*).—As a leguminous fodder plant for the drier areas this clover is outstanding, but when contained in Drooping Flowered Clover seed is of comparatively little value owing to the conditions usually existing where the latter is grown. The seeds (Fig. 2) very closely resembles that of Drooping Flowered Clover, but is slightly wider in comparison with its length, and the radicle (right portion of seed in drawing) usually doubles back further along the remainder of the seed. It is very difficult, however, to definitely separate the two, and in any case the most harm the presence of Cluster Clover can do is to reduce the amount of Drooping Flowered Clover in the seed obtained.

Woolly Clover (*Trifolium tomentosum*).—This clover is worthy of encouragement in the Wheat Belt, but must be regarded as more or less a weed under the favourable condidtions existing where Drooping Flowered Clover thrives. The seed (Fig. 3) is reddish-yellow in colour with a mottling of dark green, and has a very prominent radicle.

Hop Clover (*Trifolium agrarium*).—An annual clover often found as a weed in lawns, and of little value in good pastures. The seed (Fig. 4) is comparatively long for its breadth, shiny and ranging in colour from a light yellow to a brown.

Suckling Clover (*Trifolium dubium*).—This is a prostrate annual sold as a pasture plant, but of minor importance. It is a common garden weed, being particularly troublesome in lawns. The seed (Fig. 5) is smooth and shiny, varying in colour from a light to a dark brown.

Barley Grass (*Hordeum murinum*).—For early feed this grass is of value, but must be regarded as a weed in permanent pastures. When dry the "seeds" are often troublesome to sheep, becoming tangled in the wool and also irritating the mouth and other parts. The name "Spear Grass" is often applied, but this should be confined to members of the genus *Stipa*. The usual form in which Barley Grass is found as an impurity is shown in Fig. 6. Here the spikelets are grouped into three, only the centre one producing a seed, the other two being sterile.

Silver Grasses (*Festuca spp.*).—Several species of Silver Grass are found as impurities, but the most common one is *F. bromoides* (Fig. 7). These grasses

have little value, and under favourable conditions should certainly be discouraged. In *F. bromoides* the flowering glume is about 7mm. long, rounded on the back and with an awn as long as itself.

Annual Brome Grasses (*Bromus spp.*).—Large Brome (*B. villosus*), Madrid Brome (*B. madritensis*), and Soft Brome (*B. hordeaceous*) (Fig. 8) are most frequently present. Like the Silver Grass they have some value in places which are unfavourable for the growth of better fodder grasses, but are harmful in permanent pastures. The flowering glume of *B. hordeaceous* is about 7 mm. long, keeled on the back, and with an awn half its length.

Yellow Weed (*Bartsia viscosa*).—This is the most serious weed yet found in samples of Drooping Flowered Clover seed, and is included in the list of Noxious Weed Seeds. It is a very free seeding annual which has taken possession of certain areas in the South-West. Unfortunately all seed which is sold direct from one farmer to another cannot be inspected, so buyers should be particularly careful when purchasing to make certain that this weed seed is not present. If any doubt exists, a sample should be forwarded to the Department for examination. The seed (Fig. 9) is brown in colour with indistinct markings and very small, measuring only about ½ mm. long by ¼ mm. wide (*i.e.*, approximately one-fiftieth and one-hundredth inch).

Catchfly (*Silene gallica*).—An annual weed belonging to the Carnation family and fairly widely distributed throughout the State. The seeds are dark, roughened, and somewhat kidney-shaped.

Flat Weeds (*Hypochoeris spp.*).—Two species are found locally, *H. glabra* and *H. radicata* (Fig. 11). They are most troublesome in lawns, as they die in summer and produce bare patches. Normally these "seeds" have a ring of hairs at the end to aid wind dispersal, but usually when present in seed samples this has been broken off. The "seeds" of the two species are very similar, being brown in colour with a roughened surface.

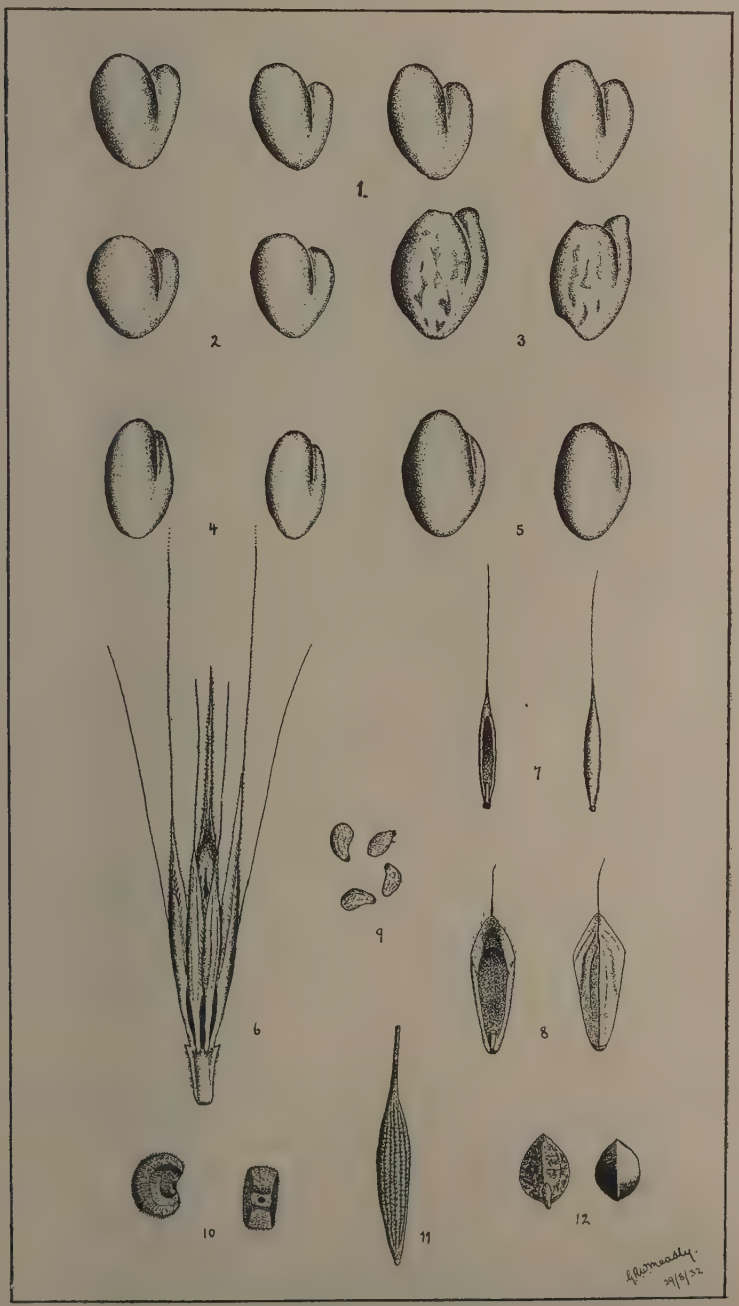
Sorrel (*Rumex acetosella*).—Sorrel is a common weed, particularly in damp and sour situations. It is a difficult plant to eradicate, but drainage, cultivation, and the growing of a smother crop are valuable factors in its control. The seed may be present either bare or with a rough reddish coating as shown in Fig. 12.

Other foreign seeds found in samples of Drooping Flowered Clover Seed include Fairy Grass (*Aira caryophyllea*), Yorkshire Fog (*Holcus lanatus*), Perennial Rye Grass (*Lolium perenne*), Timothy (*Phleum pratense*), and Toadrush (*Juncus spp*).

EXPLANATION OF PLATE.

Seeds of—

1. Drooping Flowered Clover (*Trifolium cernuum*) × 13.
2. Cluster Clover (*Trifolium glomeratum*) × 13.
3. Woolly Clover (*Trifolium tomentosum*) × 13.
4. Hop Clover (*Trifolium agrarium*) × 13.
5. Suckling Clover (*Trifolium dubium*) × 13.
6. Barley Grass (*Hordeum murinum*) × 2.
7. Silver Grass (*Festuca bromoides*) × 3.
8. Soft Brome Grass (*Bromus hordesaceous*) × 3.
9. Yellow Weed (*Bartsia viscosa*) × 10.
10. Catchfly (*Silene gallica*) × 9.
11. Flat Weed (*Hypochoeris radicata*) × 4.
12. Sorrel (*Rumex acetosella*) × 10.



Drooping Flowered Clover Seed.

HERD TESTING.

THE OFFICIAL AUSTRALIAN PURE BRED DAIRY CATTLE PRODUCTION TESTING SCHEME.

Conducted by Dairy Branch, Department of Agriculture, Western Australia, Year ending 30th June, 1932.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Butter Fat.	Owner.	Sire.
						lb.	lb.	%	lb.		
MATURE COWS (OVER 5 YEARS OLD)—STANDARD 350 LBS. BUTTER FAT.											
East View Lucky Pretty Maid 3rd	A.I.S.	8481	2 11 24	10-3-31	273	40½	13,921	4·0	557·63	A. E. Grant	East View Lucky Boy, 590
Koojan Dame	Guernsey	1252	18 6-24	22 4 31	273	33½	13,000	4·02	522·78	Denmark Stud Farm	Robin of Nundorah, 417
Darbalara Melba 69th	A.I.S.		6 11 24	10-8-31	273	26	10,668	4·54	499·37	W. G. Burgess	Re-echo of Darbalara
Darbalara Melba 42nd	do.		26-8-21	1-7-31	273	23½	11,245	4·39	492·27	do.	Limelight of Darbalara
Claremont Belle 4th	do.		26 4 24	3-7-31	273	14½	11.353	4·22	472·31	Claremont Hospital for Insane	Claremont Telyarup Prince, 2352
Hope 3rd of The Hill	do.		6 1 25	13 6-31	273	16½	11.059	4·12	453·92	W. G. Burgess	Crescent of the Hill, 2016
Kurrawong Katheleen 5th	do.		13-12-25	5-7-31	273	15	10,755	4·07	438·14	do.	Kurrawong Premier, 1212
Primrose (foundation cow)	do.		1924	14-9-31	273	22	9.591	4·45	427·25	D. Bevan	Triumph of Berry
Claremont Maggie	do.		12 3 26	5-9 31	273	14½	11.293	3·76	425·81	Claremont Hospital for Insane	Sunnyvale Searchlight, 2302
Greenmount Charming Bells	Jersey	17987	18-7-24	27 9-31	273	16	7,623	5·46	415·16	A. J. B. Strempel	Werribee Starbrights King, 2602
Banyule Silvermine 38th	do.	18817	19-10-25	31 7 31	273	19½	7,640	5·41	413·16	Sabina Vale Stud Farm	Wotton Airman (imp.), 2716
Grassvale Lady Fowler 3rd	do.	19111	20 5 25	4 7-31	240	20	8,160	5·07	406·47	R. H. Rose	Rye Duke of Glen Iris, 1994
Daphne 7th of the Hill	A.I.S.		15 5 26	4-10-31	273	31	9,267	4·36	404·87	W. G. Burgess	Crescent of the Hill, 2016
Minnamurra Holly	Guernsey	953	5 1 23	20-4-31	273	19	8,367	4·80	404·45	Muresk Agricultural College	Minnamurra Favourite Prince, 294
Grassvale Starbrights Daisy	Jersey	20873	24-8 25	15 10 30	273	20½	10 007	3·97	397·89	C. H. Ironmonger	Starbright's Sweet Duke of Glen Iris, 3710
Claremont Mabel 2nd	A.I.S.		1 6-26	5-9 31	273	35½	9.991	3·95	394·93	Claremont Hospital for Insane	Claremont Telyarup Prince
Raleigh Ethel 13th	A.I.S.		9-9-26	24-9-31	273	25	9,090	4·37	395·44	D. Bevan	Raleigh Barrister
Kurrawong Pride 4th	do.		17 11 25	6 6 31	273	23	10.109	3·89	390·20	W. G. Burgess	Premier of Kurrawong, 1212
Juadine Juliet 2nd	Jersey	20911	18-8 25	14 11-30	273	22	6,426	6·07	389·31	Miss Hancock	Garden Hill Fascinator, 2754
Ventonia Buttercup	do.	12827	30-5 22	28 6 31	273	14½	7.123	5·55	388·89	R. H. Rose	Ingot of Banyule, 1413
Lonswood Lady Grey	do.	17951	18 6 24	19-10-30	273	16	8.058	4·77	384·74	A. J. B. Strempel	Lord Fowler of Dardanup, 4016
Greenmount Gay Lady	do.	20904	20-3-25	2-6-31	273	18	6.729	5·69	382·10	do.	Werribee Starbright's King, 2602
Moorlands Lydia	do.	19107	22-12-24	27 4 31	240	19½	7,890	4·76	375·75	P. Rose	Roelands Topnotch, 4011
Greenmount Bo-Peep	do.	20902	24-6-25	17-5 31	273	22	7,206	5·15	370·65	A. J. B. Strempel	Werribee Starbright's King, 2602
Sparkle of Trelawny	do.	20914	16 5-24	15 9-31	273	21	7,458	4·94	369·55	Miss Hancock	Trelawny, 3436
Denmark Anne	Guernsey	1164	2 3 25	17 6-31	273	17	7.596	4·83	367·59	Denmark State Farm	Lenwood of Wollongbar, 381
Grassvale Jess	Jersey	20872	5-8-25	14 10-30	273	19	8.247	4·45	364·94	C. H. Ironmonger	Starbright's Sweet Duke of Glen Iris, 3710
Roelands Bright Lass	do.	14322	3 2-22	24-2-31	273	22	6 996	5·2	353·60	W. Hull	Makarini, 995
Grassvale Golden Cream 2nd	do	24926	23 4-26	14 8 31	273	26	6,648	5·23	348·23	R. H. Rose	Rye Duke of Glen Iris, 1994

Waterside Sunlight	A.I.S. ...	...	25-10-22	21-8-31	273	10	6,990	4·75	331·35	Muresk Agricultural College	Belcown of Wollongbar, 415
Kurrawong Royal Lady ...	do. ...	...	6-4-25	10-2 31	210	27	7,740	4·07	314·76	Wooroloo Sanatorium	Masher of Mayfield, 1135
Spurfield Alma	Guernsey ...	1049	14 11-24	21-6 31	273	15	6,465	4·78	308·97	W. G. Burgess ...	Count Hughes of Cosey Camp, 2011
Denmark Rosa	do. ...	1429	15-12-25	28 8 31	273	15	5,760	5·31	305·71	Muresk Agricultural College	Milton's Steadfast, 292
Capel Lass	Jersey ...	24,905	1-8-25	12-4-31	273	20½	6,936	4·39	302·92	Denmark State Farm	Rose Chief of Wollongbar, 130
Wollongbar Golden Pearl 5th ...	Guernsey ...	1,128	8 9-24	14 9-31	273	14	5,412	5·55	299·98	B. W. Prowse ...	Brown Fern of Glen Iris, 1364
Nooka Queen	Jersey ...	23,664	16-1-26	3 5-31	273	18	5,904	5·00	297·00	Muresk College ...	Wollongbar Judge, 184
Blanche 5th of Minathorpe ...	A.I.S. ...	...	16 5 26	27 8-31	273	14	7,572	3·87	294·21	S. P. Herbert ...	Jessie King of Sarnia, 4678
Moorlands Gwen	Jersey ...	20,890	13 10-25	25-8 31	273	13½	5,275	5·33	279·83	R. Bee	Collier of Darbalara
Nooka Vanity	do. ...	23,665	16 5-25	27-4-31	273	14	5,007	5·48	274·33	P. Rose	Colonel of Melrose, 4015
Minnamurra Fairy Queen ...	Guernsey ...	1,592	1-8 26	11-7-31	210	18	5,115	5·35	267·08	S. P. Herbert ...	White Prince of Roelands, 3153
Dinah 2nd of Wollongbar ...	do. ...	832	13-2 22	11 10-30	240	18	5,940	4·47	265·77	Giblett & Johnston ...	Minnamurra Golden Lad, 402
Wollongbar Gladness 2nd ...	do. ...	631	10 5-21	30-11-30	273	10	5,085	5·10	261·34	Denmark State Farm	Wollongbar Judge, 184
Golden Noble Princess of Glen Iris	Jersey ...	12,965	25-8 22	13-5-31	240	9	4,290	5·8	248·92	do.	Faithful Fido of Wollongbar, 81
Wollongbar Realm 2nd... ...	Guernsey ...	1,151	22 11 23	12 8 31	210	14	6,385	4·63	249·84	W. Padbury	Mercede's Prince of Glen Iris, 1917
Hamel Lea Pit-a-Pat	Jersey ...	20870	20-10-25	21-3-31	240	11	4,800	5·14	246·72	Muresk Agricultural College	Wollongbar Bellman, 334
Blanche 4th of Minathorpe ...	A.I.S. ...	...	16-7-25	1-9-31	240	7	6,255	4·08	245·43	W. Hull	Bracken Chief of Hamel Lea, 2783
Mokine Heroine 3rd	Jersey ...	24948	28 7-26	24-9 31	273	15	5,385	4·44	238·84	R. Bee	Collier of Darbalara
Wollongbar Velvet	Guernsey ...	774	16 5-20	11-12-30	273	15½	5,701	4·03	230·96	T. H. Wilding ...	Mokine The Hood
Lingelea Fancy	Jersey ...	6674	23-9-17	13 8 31	180	19½	5,085	...	223·56	Denmark State Farm	Faithful Fido of Wollongbar, 81
Tessie of Garden Hill	do. ...	17957	28-9-24	31-8-31	150	23	4,215	5·29	222·24	W. Hull	Retford Mariposa, 896
Hamel Lea Bracken's Fancy ...	do. ...	20867	24 7-24	8-6 31	240	16½	4,680	4·72	220·71	W. Padbury	Cream Socks of Glen Iris, 1410
Noraleda 3rd of Roelands ...	do. ...	14338	19-2-23	22 3 31	240	8½	4,290	4·9	212·25	W. Hull	Bracken Chief of Hamel Lea, 2783
Waterside Rose	A.I.S. ...	...	28-7-22	29-9-31	120	27	4,350	4·49	193·50	do.	Brown Fern of Glen Iris, 1364
Wollongbar Parsons Red Rose 31st	Guernsey ...	985	21-11 22	11-3-31	273	11	3,633	5·3	183·56	Wooroloo State Farm	Premier of Mayfield, 511
Pansy 2nd (foundation cow) ...	A.I.S. ...	...	0-0-24	5-7-31	180	11	4,095	4·1	168·51	Denmark State Farm	Rose Boy of Wollongbar, 316
Grassvale Lady Fowler 6th ...	Jersey ...	24928	20-6 26	2-7-31	90	22	2,205	5·2	116·07	D. Bevan	Premier of Blackheath
Grassvale Sweet Duchess ...	do. ...	23692	9-9 25	13-7-31	60	27½	1,725	5·2	90·96	R. H. Rose	Carnation's Masterpiece of Garden Hill, 206
Moorland's Bloom	do. ...	20887	4-6-25	6-6-31	30	32	960	4·6	43·80	R. H. Rose	Starbright's Sweet Duke of Glen Iris, 3710
										P. Rose	Grafter of Melrose, 3560

COWS OVER 4½ YEARS AND UNDER 5 YEARS—STANDARD 330 LBS. BUTTER FAT.

Gold of East View	A.I.S. ...	10940	1-5-26	14-1-31	273	25	12,675	4·01	508·73	W. G. Burgess ...	Mariner of Greyleigh, 587
Moorlands Ada	Jersey ...	23679	25-5-26	17-4-31	273	13	8,454	5·05	465·01	P. Rose	Colonel of Melrose, 4015
Dahlia 4th of Raleigh	A.I.S. ...	...	2-12-26	16-7-31	273	28	11,994	3·82	457·98	D. Bevan	Union Jack of Raleigh, 2375
Claremont Molly 5th	do. ...	...	21-3-27	11-9-31	273	33½	11,185	4·07	455·09	Claremont Hospital for Insane	Searchlight of Sunnyvale
Moorlands April	Jersey ...	23687	3-9-26	10-6-31	273	16	7,908	5·46	431·24	P. Rose	Colonel of Melrose, 4015
Koojan Bonnie Jean	Guernsey ...	1612	28 3-26	13-2-31	273	16½	7,385	5·70	423·81	A. W. Padbury ...	Robin of Nundorah, 417
Koojan Ida	do. ...	1900	3-2-27	15-9-31	273	26	7,403	5·40	409·49	do.	Robin of Nundorah, 417
Greenmount Charming Bells 2nd	Jersey ...	23708	12-3-26	27 11 30	273	16	6,453	6·05	390·69	A. J. B. Strempel ...	Cheer Up of Hamel Lea, 4307
Pet 5th of Kurrawong	A.I.S. ...	...	2-8-26	10-7-31	273	17	9,606	4·03	389·87	A. E. Grant	Premier of Kurrawong
Nooka Iris	Jersey ...	23662	25-5-26	27 11 30	273	25	7,350	5·29	388·82	S. P. Herbert ...	Jessies King of Sarnia, 4578
Venus 7th of Raleigh	A.I.S. ...	...	3-10 26	12-6-31	273	29	10,182	3·70	378·39	D. Bevan	Union Jack of Raleigh, 2375

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Butter Fat.	Owner.	Sire.
						lb.	lb.	%	lb.		
COWS OVER 4½ YEARS AND UNDER 5 YEARS—STANDARD 330 LBS. BUTTER FAT—*continued.*											
Diamond 3rd of Raleigh ...	A.I.S. ...	...	19–11–26	13–9–31	273	27	9 726	3·78	366·85	D. Bevan	Union Jack of Raleigh 2375
Moorlands Olive	Jersey ...	26383	16–7–26	30–6–21	273	14½	8.698	4·12	358·86	P. Rose	Colonel of Melrose, 4015
Lonswood Lady Grey 4th ...	do. ...	23700	11 9 26	4–9 31	273	21½	7,474	4·79	357·44	R. W. Prowse ...	Hamel Lea Bracken Chief, 2783
Wollongbar Betty 2nd	Guernsey ...	1571	4 7·26	23–5–31	273	14	6,447	5·41	348·90	Muresk Agricultural College	Bounty of Wollongbar, 336
Minnamurra Orvieto	do. ...	1597	4–8 26	11 4 31	273	18	5,989	5·77	344·35	Giblett & Johnston...	Minnamurra Golden Lad, 402
Gold X. of Raleigh	A.I.S. ...	...	15 11 26	14 7–31	273	18	8.394	3·99	330·07	D. Bevan	Pacific of Raleigh, 1733
Elsie 4th of Raleigh	do. ...	...	24 1–27	19–8–31	273	24½	8.488	3·68	312·48	do.	Union Jack of Raleigh
Wooraloo Pride 2nd	do. ...	15146	21 7–26	3–4–31	180	24½	4,710	4·3	206·34	Wooroloo State Farm	Commercial of Blackheath
Minnamurra Joyce	Guernsey ...	1866	14–10–26	23–9–31	150	25	4 365	4·3	190·05	Giblett & Johnston ...	Minnamurra Golden Lad, 402
Koojan Jess	do. ...	1570	14–7–26	28–1–31	210	14	3.120	5·1	161·13	Denmark State Farm	Koojan Golden Governor, 595
Lupin 2nd of Claremont ...	A.I.S. ...	...	27–7–26	19–3 31	240	5½	3 885	3·8	150·81	Baily Bros.	Searchlight of Sunnyvale, 2302
COWS OVER 4 YEARS AND UNDER 4½ YEARS—STANDARD 310 LBS. BUTTER FAT.											
Kitty 8th of Kurrawong ...	A.I.S. ...	...	6 8–26	1–2–31	273	18	9,114	4·7	423·00	W. G. Burgess ...	Premier of Kurrawong, 1212
Moorlands Biddy	Jersey ...	24915	10–5–27	8–7–31	273	14½	7.662	5·47	419 12	P. Rose	Colonel of Melrose, 4015
Nancy 9th of Raleigh ...	A.I.S. ...	...	30 4–27	17–7–31	273	23	9,084	4·58	416·92	D. Bevan	Union Jack of Raleigh, 2375
Moorland's Bridget	Jersey ...	24920	1–7–27	13–7–31	273	12	7,831	4·99	382·37	P. Rose	Colonel of Melrose, 4015
Grassvale Montrose Maid ...	do. ...	24929	8–6–27	14 9–31	273	24	7.332	5·0	365·72	R. H. Rose	Montrose East of Glen Iris, 4140
Grangelea Buttercup	do. ...	26388	21–3 27	19–7–31	273	21	6,948	4·9	344·89	Sabina Vale Stud Farm	Grangeleas Dairy V.C., 5079
Moorland's Bebe	do. ...	24912	21–4–27	30–6–31	273	11½	7.594	4·5	343·71	P. Rose	Grafter of Melrose, 3560
Pentland Blossom 5th of Claremont	A.I.S. ...	15070	2 5 27	7–5 31	273	19½	8.683	3·8	341·65	Claremont Hospital for Insane	Telyarup Prince of Claremont, 2352
Muresk Buttercup	Guernsey ...	1799	19 4–27	6–9–31	273	19½	6 073	5·3	322·09	Muresk Agricultural College	Triumph of Wollongbar, 513
Muresk Carnation	do. ...	1800	3 5–27	22–8–31	273	17	6,531	4·92	321·46	do. ...	Triumph of Wollongbar, 513
Juadine Sparkle	Jersey ...	24716	12 8–26	10–6 31	273	11	6 663	4·73	315·01	Miss Hancock ...	Juadine Fop, 5797
Denmark Rosa 2nd	Guernsey ...	1793	6 2–27	18–4–31	273	12½	5.497	5·38	295·97	Denmark State Farm	Rose Chief of Wollongbar, 130
Moorland's Brenda	Jersey ...	24919	10 7–27	23–7–31	273	9½	6.448	4·44	286·49	P. Rose	Grafter of Melrose 3560
Minnamurra Judy	Guernsey ...	1868	4–4–27	21–7 31	210	15	4 905	5·6	276·66	Giblett & Johnston ...	Judge of Wollongbar, 184
Minnamurra Millicent	do. ...	1872	28 10–26	13–3 31	273	11	4,463	4·82	215·36	Giblett & Johnston ...	Minnamurra Golden Lad, 402
Rosemont Lady 4th	A.I.S. ...	14970	18–8–27	30–11–31	150	25	4 815	4·3	208·59	W. G. Burgess ...	Crescent of the Hill 2016
Claremont Lucy 3rd	do. ...	...	12–7 27	22–9 31	150	22	4,230	4·15	175·92	Claremont Hospital for Insane	Telyarup Prince of Claremont, 2352
Minathorpe Carnation 2nd ...	do. ...	...	8–5–27	2 11–31	120	19	3,615	3·7	136·20	R. Bee	Collier of Darbalara
Grassvale Montrose Nora ...	Jersey ...	24930	19–7–27	30 8–31	60	21	1,440	5·37	77·20	R. H. Rose	Montrose East of Glen Iris, 4140
Denmark Rose Lady	Guernsey ...	1795	22·8–27	6–12 31	60	21	1,425	4·59	64·36	Denmark State Farm	Rose Chief of Wollongbar, 130

COWS OVER 3½ YEARS AND UNDER 4 YEARS—STANDARD 290 LBS. BUTTER FAT.

Sally of the Hill	A.I.S. ...	...	8–10–27	30–6–31	273	15½	1,011	4·23	465·79	W. G. Burges ...	Crescent of the Hill, 2016
Koojan Bonny Elizabeth ...	Guernsey ...	1899	23–3–27	28–1–31	273	24	7,077	5·88	411·77	A. W. Padbury ...	Robin of Nundorah, 417
Koojan Mordern Lady 5th ...	do. ...	1902	17–3–27	22–1–31	273	24½	7,424	5·22	387·54	do.	Koojan Golden Governor
Limelights' Camelia of Wangara	A.I.S. ...	...	24–7–27	26–2–31	273	31	9,273	4·1	381·04	W. G. Burges ...	Limelight of Darbalara
Denmark Rose Dame	Guernsey ...	1794	19–8–27	19–7–31	273	11	8,508	4·35	369·86	Denmark State Farm	Rose Chief of Wollongbar, 130
Venus 8th of Raleigh	A.I.S. ...	...	3–2–28	24–9–31	273	20	9,795	3·64	357·11	D. Bevan	Royal Standard of Darbalara
Gold 11th of Raleigh	do. ...	...	17–10–27	15–5–31	273	30	9,240	3·85	355·75	do.	Standard of Darbalara
Glanavon Famous Star ...	do. ...	...	30–8–27	12–6–31	273	15	8,220	4·01	329·98	do.	Premier of Blackheath
Denmark Pamela	Guernsey ...	1791	6–10–27	25–5–31	273	12½	5,332	5·90	314·81	Denmark State Farm	Rose Chief of Wollongbar, 130
Tulip 2nd of Brush Grove ...	A.I.S. ...	18109	3–7–27	18–1–31	273	17	8,871	3·49	310·04	E. C. Melville ...	Ardee of the Hill, 3002
Spring Park Fox Queen ...	Jersey ...	25066	2–8–27	27–3–31	273	15	4,890	6·03	296·52	S. P. Herbert ...	Prince Marinora of Grassvale, 4582
Nooka Pearl	do. ...	28189	2–12–27	11–9–31	273	12	5,286	5·5	290·04	S. P. Herbert ...	Jessie's King of Sarnia, 4578
Grassvale Golden Rye 2nd ...	do. ...	24947	21–10–27	19–7–31	273	12	5,141	5·53	290·02	R. H. Rose	Mokine Christopher Columbus 1999
Denmark Rose Marie	Guernsey ...	1796	10–10–27	11–5–31	273	4½	3,658	5·73	209·53	Denmark State Farm	Wollongbar Reformer, 538
Glanavon Pretty Pearl ...	A.I.S. ...	...	2–9–27	24–8–31	210	10	4,170	4·5	181·08	D. Bevan	Premier of Blackheath

COWS OVER 3 YEARS AND UNDER 3½ YEARS—STANDARD 270 LBS. BUTTER FAT.

Toora Victress	do. ...	...	7–3–28	12–8–31	273	14	7,642	4·65	448·19	W. G. Burges ...	Victor of Darbalara, 2384
Nooka Carnation	Jersey ...	25218	17–5–28	28–7–31	273	20½	7,536	5·41	407·74	S. P. Herbert ...	Jessie's King of Sarnia, 4578
Greenmount Bonnie Lass ...	do. ...	28237	23–3–28	15–5–31	273	20	6,750	6·00	407·61	A. J. B. Strempel ...	Werribee Starbright's King, 2602
Empress 4th of the Hill ...	A.I.S. ...	...	26–5–28	10–9–31	273	28	8,709	4·20	365·35	W. G. Burges ...	Crescent of the Hill, 2016
Spangle 8th of the Hill ...	do. ...	...	17–4–28	22–9–31	273	23	7,599	4·68	355·42	do.	Crescent of the Hill, 2016
Moorlands Cora	Jersey ...	28221	13–2–28	19–5–31	240	10	6,690	5·3	354·66	P. Rose	Grafter of Melrose, 3560
Moorlands Chloe	do. ...	28214	2–5–28	20–6–31	240	15	6,120	5·67	340·62	do.	Colonel of Melrose, 4015
Muresk Rose	Guernsey ...	2156	9–5–28	7–6–31	273	13	5,994	5·62	337·09	Muresk Agricultural College	Triumph of Wollongbar, 513
Juadine Peerless Lily 3rd ...	Jersey ...	28183	29–9–28	1–10–31	273	16	5,823	5·76	333·88	Miss Hancock ...	Larry of Juadine, 513
Telyarup Duchess 1st	A.I.S. ...	...	9–12–28	21–6–31	273	21½	8,660	3·91	328·68	A. E. Grant	Baron of Darbalara
Moorlands Cherry	Jersey ...	28213	20–5–28	22–5–31	273	13	6,279	5·08	319·26	P. Rose	Colonel of Melrose, 4015
Nooka Bright Queen	do. ...	28186	29–11–27	28–3–31	273	19	5,982	5·10	307·60	S. P. Herbert ...	Jessie's King of Sarnia, 4578
Lady Jean 4th of Jerarra Park ...	A.I.S. ..	13102	30–10–27	20–11–30	273	20	7,815	3·83	299·72	E. C. Melville ...	Tulips Hero of Hill View
Folly of Aorangi	do. ...	...	18–6–27	23–10–30	273	5	7,770	3·79	294·73	do.	General Maud of Aorangi, 1014
Mokine Columbine 5th	Jersey ...	24943	20–8–27	17–1–31	273	10	5,040	5·84	292·51	T. H. Wilding ...	Mokine the Hood, 4925
East View Pendant	A.I.S. ...	18339	18–6–28	18–6–31	273	13	7,809	3·68	286·70	A. E. Grant	Sultan of East View
Claremont Hilda 3rd	do. ...	...	21–1–28	13–3–31	273	18	6,864	4·1	281·71	Claremont Hospital for Insane	Searchlight of Sunnyvale
Claremont Laura 2nd	do. ...	...	6–12–27	26–4–31	273	12½	6,472	4·35	281·53	do.	Telyarup Prince of Claremont
Muresk Violet	Guernsey ...	2157	26–6–28	9–9–51	273	16	5,298	5·28	279·76	Muresk Agricultural College	Wollongbar Triumph, 513
Wooroloo Gem 3rd	A.I.S. ...	...	25–12–28	9–7–31	273	15	6,345	4·4	278·99	Wooroloo State Farm	Triumph of Pine Creek, 2515
Capel Carnation	Jersey ..	24904	15–9–27	20–11–30	273	13	5,814	4·79	277·79	B. W. Prowse ...	Montrose East of Glen Iris, 4140
Moorlands Coral	do. ...	28222	15–8–28	15–8–31	273	12½	5,227	5·33	273·56	P. Rose	Grafter of Melrose, 3560
Moorlands Celia	do. ...	28210	17–5–28	26–6–31	240	11	5,520	4·80	264·03	do.	Colonel of Melrose, 4015
Colmyn's Topaz Girl	do. ...	24898	9–7–27	3–11–30	240	14	4,710	5·54	260·85	C. H. Ironmonger ..	Milord of Rocklands, 5611
Valerie of Aorangi	A.I.S. ...	...	14–7–27	12–10–30	240	10¾	6,167	4·26	261·06	E. C. Melville ...	General Maud of Aorangi, 1014
Koojan Gem	Guernsey ...	1982	15–4–27	2–10–30	273	7½	4,822	5·17	249·28	A. W. Wilson ...	Koojan Golden Governor, 595
Denmark Rose Lady	do. ...	1795	22–8–27	22–12–30	273	17	4,911	5·05	248·06	Denmark State Farm	Rose Chief of Wollongbar, 130
Clarendon Eyre Betty	Jersey ...	...	28–4–28	27 5 31	210	25½	5,385	4·4	238·24	Sabina Vale Stud Farm	Clarendon Eyre Eminent Achievement

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Butter Fat.	Owner.	Sire.
						lb.	lb.	%	lb.		
COWS OVER 3 YEARS AND UNDER 3½ YEARS—STANDARD 270 LBS. BUTTER FAT—*continued.*											
Tipperary Matilda ...	A.I.S.	17901	2-4-28	16-8-31	240	9½	5,715	4·12	235·05	A. E. Grant	Villiers of Darbalara
Viola 2nd of Wangara ...	do.	17888	23-8-27	4-12-30	273	10	4,650	4·05	190·17	do.	Limelight of Darbalara, 1105
Claremont Biddy 9th ...	do.	...	28-8-28	14-10-31	180	16	4,650	3·77	172·97	Claremont Hospital for Insane	Clinker of Claremont, 2465
Madame 1st of Tipperary ...	do.	...	16-9-27	26-11-30	273	11	4,548	3·65	171·05	A. E. Grant	Villiers of Darbalara
COWS OVER 2½ YEARS AND UNDER 3 YEARS—STANDARD 250 LBS. BUTTER FAT.											
Nooka Wild Rose ...	Jersey	28191	31-12-28	7-9-31	273	21½	6,619	5·43	358·55	S. P. Herbert ...	Monfrose East of Glen Iris, 4140
Moorlands Clytie ...	do.	28218	1-9-28	20-8-31	273	22½	7,507	4·74	355·72	P. Rose	Grafter of Melrose, 3568
Gem 2nd of Wooroloo ...	A.I.S.	2518	30-11-27	5-10-30	273	20	7,830	4·37	342·24	Wooroloo State Farm	Commercial of Blackheath, 2001
Lofty 2nd of Karawarra ...	do.	15950	5-2-29	-9-31	273	21	7,833	4·11	321·67	W. G. Burgess ...	Sailor of Karawarra
Moorlands Crystal ...	Jersey	28225	31-7-28	14-7-31	273	12½	6,352	5·00	316·54	P. Rose	Grafter of Melrose, 3568
Telyarup Thelma 2nd ...	A.I.S.	2506	22-11 28	1-7-31	273	10½	7,276	4·34	315·35	A. E. Grant	Baron of Darbalara
Moorlands Camilla ...	Jersey	28207	4-7-28	12-6-31	273	12½	6,532	4·90	313·55	P. Rose	Colonel of Melrose, 4015
Alice of Wooroloo ...	A.I.S.	...	19-4-28	18-11-30	273	22	7,281	4·16	303·24	Wooroloo State Farm	Triumph of Pine Creek, 2515
Juadine Sparkle 3rd ...	Jersey	28185	15-9-28	5-8-31	273	17	5,676	5·14	289·42	Miss Hancock ...	Twylish Fox of the Valley
Moorlands Clara ...	do.	28215	18-8-28	10-7-31	273	12	5,796	4·99	286·12	P. Rose	Grafter of Melrose, 3568
Muresk Primrose ...	Guernsey	2527	3-3-29	12-9-31	273	17	5,331	5·36	284·30	Muresk Agricultural College	Triumph of Wollongbar
Pansy 3rd of Claremont ...	A.I.S.	2413	18-9-28	30-6-31	273	22½	7,752	3·59	281·56	Claremont Hospital for Insane	Clinker of Claremont
Tipperary Virginia 1st ...	do.	17903	17-7-28	15-2-31	273	20	6,495	4·3	279·00	A. E. Grant	Villiers of Darbalara, 2386
Wooroloo Gem 3rd ...	do.	2519	25-12-28	9-7-31	273	15	6,345	4·4	278·99	Wooroloo State Farm	Triumph of Pine Creek
Telyarup Milkmaid 2nd ...	do.	2505	15-10-28	14-6-31	240	12	7,440	3·72	277·17	A. E. Grant	Baron of Darbalara
Tipperary Pansy ...	do.	2442	2-12-28	10-8-31	273	16	6,273	4·18	272·24	do.	Villiers of Darbalara
Della 1st of Telyarup ...	do.	...	11-11-28	21-8-31	273	6	6,348	4·02	255·00	do.	Baron of Darbalara
Mokine Heroine 5th ...	Jersey	34358	25-9-28	16-9-31	273	11	5,328	4·72	250·08	T. H. Wilding ...	Twylish Fox of the Valley
Denmark Irish Rose ...	Guernsey	2154	11-10-28	1-9-31	273	10	4,170	5·77	231·09	Denmark State Farm	Rose Chief of Wollongbar. 130
Tipperary Camellia ...	A.I.S.	2371	5-8-28	12-3-31	180	23	4,980	3·99	197·28	W. G. Burgess ...	Searchlight of Darbalara
Liberton Patricia ...	do.	2441	1-1-29	5-9-31	240	7½	5,340	3·62	193·20	A. E. Grant	Limit of East View
Springpark Violet ...	Jersey	24903	21-3-28	6-12-30	240	9	2,940	6·20	181·92	W. Padbury	Prince Marinora of Grass Vale
Burnside Queen ...	Guernsey	2542	8-4-29	8-10-31	120	19½	2,925	4·7	140·73	Giblett & Johnston	Minamurra Prairie Don, 743
COWS UNDER 2½ YEARS—STANDARD 230 LBS. BUTTER FAT.											
Wooroloo Rose 2nd ...	A.I.S.	2523	27-4-29	23-9-31	273	22½	7,882	4·55	359·02	Wooroloo State Farm	Triumph of Pine Creek
Bella 3rd of the Hill ...	do.	...	13-5-28	30-10-30	273	31	7,893	4·12	325·70	W.G. Burgess ...	Crescent of the Hill, 2216
Moorlands Daphne ...	Jersey	31222	13-3-29	13-6-31	273	11½	5,615	5·62	315·25	P. Rose	Melrose Raleigh, 5860
Tipperary Melba 2nd ...	A.I.S.	2375	23-12-28	27-5-31	273	20	7,185	4·48	314·09	W. G. Burgess ...	Villiers of Darbalara
Burnside Judy ...	Guernsey	2540	5-5-29	19-7-31	273	14½	5,585	5·60	312·57	Giblett & Johnston ...	Minnamurra Prairie Don, 743

Denbank Rosa 6th	do.	2923	5 4 29	14-6-31	273	104	5,986	5·05	302·32	Denmark State Farm	Wollongbar Reformer, 538
Grangelea Daphne 2nd	Jersey	33036	4-8-29	13-8-31	273	19	5,857	5·14	301·36	Sabina Vale Stud Farm	Grangelea Dandy
Koojan Polly	Guernsey	2665	13-12-28	16-10-30	273	17	5,736	5·13	294·50	A. W. Padbury	Koojan Golden Governor, 595
Moorland's Duchess	Jersey	31239	11 7 29	8-7-31	273	10	5,790	5·03	291·82	P. Rose	Moorlands Romeo
Banyule Silvermine 59th	do.	29033	10-2-29	10-3-31	273	18	5,979	4·8	288·79	Sabina Vale Stud Farm	Banyule Superstrain, 4529
Moorlands Doris	do.	31235	14-5-29	19-7-31	273	11½	6,094	4·52	275·83	P. Rose	Moorlands Romeo
Greenmount Gipsy Lass	do.	28239	6 3 29	5-5-31	273	13	4,314	6·45	272·39	A. J. B. Strempel	Werribee Starbright's King, 2602
Greenmount Gipsy Maid	do.	28240	8 3 29	20 4 31	273	15	4,785	5·66	271·00	do.	Werribee Starbright's King, 2602
Snowdrop 22nd of Kurrawang	A.I.S.	18229	14-9-28	7-1-31	273	24	6,752	4·1	270·75	W. G. Burgess	Merry Count of Berry, 2692
Mokine Miss Fox	Jersey		24-11-29	22-9-31	273	17	5,286	4·90	259·90	T. H. Wilding	Twylish Fox of the Valley
Moorelands Doreen	do	31234	21 5 29	25-6-31	273	10	5,145	5·02	258·05	P. Rose	Moorlands Raleigh
Daisy 2nd of Juadine	do.	34342	24 6 29	20 5 31	273	14½	5,338	4·83	258·00	Miss Hancock	Twylish Fox of the Valley
Juadine Juliet 6th	do.	34344	20-10-29	20 9 31	273	13	4,224	5·99	251·51	do.	Mokine Repulse
Koojan Bonnie Buttercup	Guernsey	2230	18-10-28	26-2-31	273	12½	4,732	5·38	251·30	A. W. Padbury	Koojan Golden Governor, 595
Claremont Star 2nd	A.I.S.	2423	1 8 29	7-9-31	273	16	5,929	4·16	249·71	Claremont Hospital for Insane	Claremont Elector
Tipperary Virginia 4th	do.	2379	18-8-29	25 9 31	273	20	5,820	4·29	249·24	W. G. Burgess	Melba's Re-Echo of Tipperary
Greenmount Buttercup	Jersey	28238	26 5 29	9 6-31	273	14	4,512	5·52	249·12	A. J. B. Strempel	Werribee Starbright King, 2602
Mokine Empire Twylish	do.		30-12-29	27-9-31	273	18	5,086	4·88	245·87	T. H. Wilding	Twylish Fox of the Valley
Grassvale Golden Cream 3rd	do.		22-8 29	2-10-31	273	11½	4,219	5·46	229·62	R. H. Rose	Choice Goods of Garden Hill
Lottie 5th of Kurrawong	A.I.S.	18225	8-10-28	12-12-30	273	20	5,880	3·89	228·99	W. G. Burgess	Premier 2nd of Kurrawong
Moorlands Dazzle	Jersey	31225	14 9 29	10-7 31	240	10½	4,186	5·34	224·43	P. Rose	Moorland's Raleigh
Greenmount Snowflake	do.	28242	30-3-29	3 5 31	273	12	4,011	5·52	221·19	A. J. B. Strempel	Werribee Starbright King, 2602
Flash of East View	A.I.S.	18831	4-10 28	22 10 30	273	20½	5,880	3·75	220·85	A. E. Grant	Mariner of Greyleigh
Muresk Tulip	Guernsey	2529	26-6-29	20-9-31	273	13½	4,360	4·95	215·99	Muresk Agricultural College	Minniamurra Gunn, 828
Belle 8th of Claremont	A.I.S.	2387	24 8 28	19 11 30	273	16	5,658	3·74	211·78	Claremont Hospital for Insane	Clinker of Claremont, 2456
Devonia Gladies	Jersey	31185	1-9-29	4-2 31	273	10	3,855	5·2	210 30	W. Hull	Grassvale Fairy's Duke 2nd
Capel's Prettiest Thing	do.	28205	14 11-28	16-11-30	273	8	4,539	4·41	200 35	B. W. Prowse	Bracken Fern of Roelands, 4014
Claremont Whitby Maid 7th	A.I.S.	2425	26 8 28	30-11 30	273	17	4,881	4·09	199·46	Claremont Hospital for Insane	Clinker of Claremont, 2456
Claremont Biddy 10th	do.	2390	11 10 28	9-11-30	273	11	4,563	4·18	190·84	do.	Duncan of Claremont, 2467
Claremont Belle 6th	do.	2386	29-9-28	23 12 30	273	15	4,365	4·34	189·33	do.	Clinker of Claremont, 2456
Capel Daisy 2nd	Jersey	34349	22-12-29	16 9-31	273	12½	3,562	5·1	183·23	B. W. Prowse	Bracken Fern of Roelands, 4014
Capel Jean	do.	34351	5-1-30	26-10-31	273	12½	4,012	4·57	183·06	do.	Bracken Fern of Roelands, 4014
Capel Centenary Girl	do.		15-10 29	4 8 31	273	9	3,792	4·90	182·98	do.	Bracken Fern of Roelands
Nooka Madiera	do.	28188	20 10 28	5 2 31	273	8½	3,131	5 8	181·84	S. P. Herbert	Jessie's King of Sarnia, 4578
Lonswood Lady Grey 9th	do.	31212	14 9 29	6 8 31	273	8	3,414	5·34	181·53	S. W. Prowse	Hamel Lea Fancy's Dapper
Tipperary Snowflake 2nd	A.I.S.	2443	1 2 29	11-6 31	240	4	3,930	4·43	174·03	A. E. Grant	Villiers of Darbalara, 2386
Lonswood, Lady Fowler	Jersey		1 11 28	28 3 31	240	15½	3,135	5·20	164·38	W. Hull	Coolup Democrat, 4917
Snowdrop 25th of Kurrawong	A.I.S.	1378	6-3-29	26 4 31	150	25	3,750	3·80	143·58	W. G. Burges	Premier 2nd of Kurrawong
Claremont Lupin 5th	do.	2407	11 10 28	16 1-31	210	16½	3,555	3·80	136·38	D. Bevan	Duncan of Claremont, 2467
Claremont Blanche 7th	do.	2393	21 3 29	27-5-31	273	9½	4,384	3·07	135·47	Bayley Bros.	Elwood of Claremont
Colmyn's Fairy Rye 2nd	Jersey	28192	10-11-28	28-11-30	210	10	2,685	4·84	130·14	C. H. Ironmonger	Rye Duke of Glen Iris, 1994
Claremont Polly 2nd	A.I.S.	2419	19 1-29	5-6-31	240	5½	3,225	3·72	112·62	Bayley Bros.	Clinker of Claremont
Colmyn's Rye Cream	Jersey	28193	16-11-28	7-2-31	150	6½	1 530	5·4	82·48	C. H. Ironmonger	Rye Duke of Glen Iris, 1994
Minnamurra Palm Olive	Guernsey	2616	30 8 29	1-1-32	30	20	600	4·48	26·88	Muresk Agricultural College	Caramana Favour
Claremont Cherry 3rd	A.I.S.	2395	2 2-29	15-7-31	30	20½	615	3 50	20·85	Claremont Hospital for Insane	Clinker of Claremont

THE MINERALOGY OF THE DANDARAGAN DISTRICT AND ITS BEARING ON PASTURES AND STOCK.

By

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The Dandaragan District embraces an area about thirty miles long in a north and south direction, and ten miles wide, lying between Moora and the west coast.

In geological structure and topographical features it is a northward continuation of the Gingin area, and closely resembles parts of the south and east of England, the surface consisting of rolling downs carved out of almost horizontal beds of chalk, glauconitic sands, and glauconitic clay shales, the outcrops of which are for the most part heavily covered with soil. The highest ridges reach an elevation of about 1,200 feet * above sea-level.

The geology of the district has been dealt with in a number of short descriptions, a list of which is attached.

Dandaragan is a grazing district chiefly noted for the excellence of the stud and fat stock reared there, including horses, oxen and sheep. These find abundant pasture on the cleared land and open forest, a pasture consisting of native herbage largely augmented by introduced grasses, clovers and other succulent vegetation. This introduction of useful fodder plants is still proceeding vigorously, extensive planting of lupins, subterranean clover, rye grasses, veldt grass, etc.; as well as hay crops, being noticeable. Such heavy mixed pastures should enable the stock to secure a well-balanced ration over the greater part of the year. The only fault observed in them is an excessive growth of Cape dandelion in places in the winter, with a tendency to smother more valuable herbage. In late summer the pastures dry up considerably and need supplementing, especially with protein-bearing and lime-bearing feeds.

The district is well supplied with water. The average rainfall over 34 years for Dandaragan townsite has been 27.18 inches. This is spread over the year as follows:—

January-March.	April-June.	July-September.	October-December.
1·33 ...	10·37 ...	12·60 ...	2·88

At the Yatheroo (south) end the rainfall is slightly heavier; at the Mungeda (north) end slightly lighter. The top soil is mostly fairly porous, so that the vegetation on the spot gets the full advantage of any rain, while streams are comparatively small and far between. The run-off is, however, sufficient to ensure that the numerous dams fill easily, whilst supplementary supplies of water are obtained from shallow wells and numerous soaks or springs. These, so far as sampled, are all of low salinity.

Stock diseases are of slight incidence. A little "Gingin rickets" in sheep, and some slight deterioration in the quality of wool, however, have been experienced at the south end. As will be apparent later, it is extremely unlikely that this is due to any deficiency unless it be of salt, or to a lack of balance in the feed, unless possibly an excessive ratio of phosphorus to lime, or, in certain places and seasons, a deficiency of leguminous herbage. At latest it appears rather to be due to some vegetable poison.

* Cowalla Bluff is 1,195 ft.

The soils of the district vary greatly in mechanical condition, from a pure coarse sand of white or yellow colour on some of the uplands, through rich sandy loams, and clay loams, to occasional areas of stiff clays and typical black "rendzina," a fertile type of soil characteristic of chalk outcrops the world over.

These soils are a result of the weathering of the underlying rock masses, and owe their present condition firstly to the mineral constituents of the underlying rocks and those which have been eroded away from above and around them, and secondly to the effect of rain, air, and micro-organisms upon those minerals, and upon the surface accumulation of rotting vegetation.

The chief rock masses disclosed are:—

(1) Soft sandstones and unconsolidated sand beds.
(2) Glauconitic sands, the weathered outcrops of which are often hard ironstones.
(3) Glauconitic clay shales.
(4) Non-glauconitic clay shales.
(5) Chalk.
(6) Phosphatic pebble beds.
(7) Recent alluvium composed of the mixed remnants of all of the preceding.
(8) Spongolite (sponge spicule rock) of limited extent, but used as building material in the town of Dandaragan, where it occurs under the soil of meadow land.

The chief mineral components of the rocks and the overlying and resulting soils are described below:—

(1) *Quartz.*—This mineral, which composes almost the whole of the sandy portion of the local rocks and soils, is of no value as a source of nutriment to plants or stock. It is, however, a necessary matrix for such nutrients, and exerts a profound influence upon the texture of the soils, keeping them friable as well as open and permeable by air and moisture.

(2) *Kaolin* (hydrous silicate of alumina).—A major constituent of the clay shales and more clayey soils, and present to some extent in all soils. Of no nutrient value but of great mechanical value in rendering the soils more compact and retentive of moisture. Mixtures of quartz and kaolin in due proportions form the mechanical bases of the most fertile of all soils in temperate regions.

(3) *Halloysite* (hydrous silicate of alumina).—A mineral closely related to kaolin, but more sticky and binding, and more retentive of moisture. It also assists in retaining metallic bases of nutritive value.

(4) *Limonite* (brown iron hydroxide).—A constituent in greater or less amount of all soils, particularly of those with a red or brown colour. Also abundant in ferruginous sandstones and ironstones. It is a most important element in the mineral complex of any area, as forming the chief source of the iron so essential for both stock and plant life. Small quantities of manganese are invariably associated with it, and these, too, are essential to living organisms, being necessary to stock if anaemia is to be avoided.

In the Dandaragan district limonite appears to be derived largely from the weathering of glauconite (see below), and many of the outcrops of glauconitic sand beds are represented by dense ferruginous sandstones or ironstones, whilst ferruginous clays result from the decomposition of glauconitic shales.

In the table of analyses attached hereto it will be seen that iron oxide (Fe_2O_3) is abundant in all the material collected throughout the district. Ironstone from Jurien paddock and the home paddock of Mungedar estate (D1 and D6) carried respectively 61 and 40 per cent. of iron oxide with appreciable traces of manganese. Four ferruginous sandstones from Jurien paddock, Mungedar (D2, 3, 12 and 13), carried 24 to 56 per cent. iron oxide. Five soils from Mungedar and Yatheroo carried 3 to 10 per cent., and others in the district, which were not sampled, plainly carried much more. The phosphatic pebble beds are highly ferruginous in places, and even the whitest of those collected, viz., that from Bowers Block 284, near Minyulo, had nearly 4 per cent. iron oxide.

Dandaragan Phosphate Deposits.
Typical Pasture Land in Chalk and Greensand Country, Block 284, South Dandaragan. Phosphate Bed runs past Vehicle to Hole in right Foreground.

No bog iron ore was observed, such as might be utilised for the manufacture of commercial stock licks for use in areas less plentfully supplied with iron.

Wherever looked for, whether in soils, rocks, or pebble beds, an appreciable amount of manganese was found to be associated with the iron, quite sufficient to supply all the requirements of pasture and stock, except perhaps on the actual chalk outcrops where the abundant calcium carbonate depresses the availability of the manganese.

(5) *Glauconite* (hydrous silicate of iron magnesium and potassium). This is usually a rare mineral in soils and rocks, but is characteristic of the chalk formation in several parts of the world, and is very abundant and almost universally distributed in the Dandaragan district. The pure mineral contains 7 per cent. of potash and 32 per cent. of iron oxide, and as it is decomposed fairly readily by the atmosphere and soil waters, it is of the greatest importance as a source of both potash and iron for plants and animals. Glauconite is a mineral which forms in small dark green grains in shallow coastal sea waters, and as most of the underlying rocks in this district appear to have been formed under such condtions it is not surprising to find glauconite distributed through almost all of them, whether sandy, clayey, or chalky, in quantities ranging from 1 or 2 per cent. up to as much as 40 per cent. of the whole rock. During the disintegration of the original beds

it finds its way into the resulting soils, where it can be detected wherever looked for. A rich black alluvial loam from the home paddock at Mungedar was especially rich in glauconite, about 14 per cent. of that mineral being present. The phosphatic beds also carry quite appreciable amounts, as the potash figures in the attached table indicate.

This wide distribution of a rather easily decomposable potash compound is of the greatest importance in maintaining healthy and vigorous pastures. In the south of England, north of France, and eastern States of the U.S.A. glauconitic sands and clays have been used for centuries for fertilising orchard and hop lands as well as pastures.

A modern use for clean glauconite is in the softening of factory and general town supplies of hard water. Inquiries have been received from both the Eastern States and England for commercial supplies, and it is probable that they may be found of suitable quality in the Dandaragan district.

(6) *Calcite* (carbonate of lime).—This mineral forms the chief constituent of the chalk deposits of the district. There is some uncertainty as to whether the numerous outcrops met with from about two miles south of Gingin to Wathingarra (Emu) Hill, a distance of 65 miles, are all portions of one bed or whether there are several such beds. That the chalk is of the same geological age at Gingin and Kayanaba has been proved palaeontologically by L. Glauert, and the writer is inclined to think it is all one bed dipping slightly southwards, and that the erosion of the valleys has left it exposed round the contours of the ridges. W. D. Campbell estimated that the bed is 40 feet thick at Emu Hill, but boring done there at my suggestion shows that it is only about 18 feet thick, which appears to be an average throughout the district.

The outcrops, being usually on gentle slopes, cover often a width of many chains and yield a very rich "rendzina" soil, a typical example of which has been analysed with the results shown in the table, viz., No. 4 from Emu Hill. Further, the benefit of this abundant supply of lime is felt in the soils below the chalk horizon, whilst for those above it which may show a deficiency of lime, it provides a source of artificial supply. Incidentally, it assists in the liberation of potash from glauconite.

One was hopeful that some portion of the chalk bed might be sufficiently free from silica to constitute a good material for cement making. At the two points sampled, however, it was found to be too highly siliceous for that purpose. (*Vide* analyses of D 10 and D 11 in the table.)

The chalk is also of importance as a guide to an horizon characterised by the presence of a pronounced bed of phosphatic pebbles which occurs at its base.

(7) and (8) *Apatite* (fluophosphate of lime) and *Dufrenite* (basic phosphate of iron).—In many parts of the district phosphatic nodules, composed largely of apatite, are found at the base of the chalk bed. Sometimes they are seen as isolated pebbles in the soil, or else *in situ* in the chalk or in the uppermost layers of the underlying glauconitic clay or sandstone. At other times they form dense masses of pebbles and boulders from one to six feet thick, cemented together with sand, clay, limonite and, in places, dufrenite. It was the last-named bright green mineral which attracted the attention of the first discoverer of these phosphate beds nearly 50 years ago, viz., Mr. John Cook, who still lives in the district and pointed out to me the site of his first discovery near Cowalla Bluff. The first analyses of them were made by the writer in 1906, and a much more detailed examination was made in the following year of a series of samples collected by W. D. Campbell, Geological Surveyor.

No reliable estimate of the average thickness of these important beds could be made on the present occasion, as the few small holes sunk in them many years

ago have fallen in, and the low outcrops on gently sloping ground do not lend themselves to exact measurement. At comparatively small expense, however, this thickness could be ascertained at two or three typical places.

W. D. Campbell's map and report suggest that he considered the phosphate beds to be confined to a narrow north and south strip of country associated with the main escarpment of the Darling Range, and possibly congregated at a few isolated points along that line. The writer's own impression is that they are continuously, though not necessarily uniformly, associated over the whole district with the base of the chalk bed, passing under the ridges in an almost horizontal plane and coming quite or almost to the surface along a contour which follows not only the face of the range but also the sinuous contours of the sides of the valleys running in from it. The outcrop is concealed over considerable stretches by the soil, but it is certain as the result of my visit that there are many more places than those mapped by Campbell where phosphatic pebble beds can be seen, or loose pebbles collected from the soil. Their influence in raising the phosphorus content of the soils and rocks to an unusually high figure over very wide areas is shown wherever these have been tested.

In detail the phosphatic pebbles are rounded and range from half an inch up to 3 or 4 inches in diameter. They are composed very largely of granular apatite, contaminated to a minor extent with grains of sand, glauconite and calcite. Apatite is a phosphatic mineral readily dissolved by weak mineral acids, and quite appreciably attacked by carbonic acid, properties which make it a valuable natural fertiliser. Mostly the pebbles are soft and porous, and of a cream colour, but not infrequently they are dark grey and much harder and denser. On Bowers Block 284, in the Koodiwoodi Ridge, associated with many pebbles of the usual type, are some much larger "stink stones." These are hard dense boulders composed of about equal parts of coarse quartz sand, and compact grey apatite, which when split give off a strong odour of hydrogen phosphide and hydrogen sulphide. Individual specimens of them yielded 15.4 and 13.7 per cent. of phosphoric oxide (Nos. 26 and 29 in the table). Other more normal nodules from various places showed phosphoric oxide 25.3 per cent. (D 22, Emu Hill); 26.3 per cent. (W.D.C. 6979, Block 1102, Cowalla); and 19.2 per cent. (L.G. 2344, Kayanaba). H. Rowley's four picked samples secured in the vicinity of Cowalla and Minyulo assayed 30.60 to 37.74 per cent. P_2O_5 with 35 to 51 per cent. of lime and 1.7 to 9.6 per cent. of iron oxide. Similar nodules from Gingin have yielded from 22 to 25 per cent. of P_2O_5 with 2.9 per cent of fluorine and 40.6 per cent. of lime, proving beyond doubt that apatite is their principal constituent.

In nearly every outcrop of the pebble beds the writer observed angular blocks of fossil wood now composed of the same mineral as the pebbles themselves, viz., apatite. Their composition has been proved by analysis (W.D.C. 6979 in the table), and their high phosphorous content (39 per cent. P_2O_5) and very porous texture give them valuable fertilising properties.

Very unevenly distributed through the pebble beds is the green iron phosphate *Dufrenite*. It has been formed by interaction between the apatite nodules and the weathering glauconite. This mineral is unfortunately insoluble in dilute mineral acid and it is improbable therefore that it should have any appreciable fertilising power in its natural state. It can, however, by chemical processes be converted into a more readily soluble form.

In the accompanying table a distinction has been drawn in most cases between the phosphoric oxide soluble in dilute acid, which is that present as apatite and slowly available as plant food, and that insoluble in dilute acid, which is present as dufrenite, and is not available as plant food.

Whilst picked nodules and fragments of fossil wood carry up to 39 per cent. of phosphoric oxide, it would be impossible to hand-pick or otherwise concentrate

those in the outcrops on a large commercial scale. If the beds are to be utilised commercially it is average values of the beds as a whole that must be considered. The figures available for different outcrops that have been examined are as follow:—

Place.	P_2O_5 soluble.‡	P_2O_5 insoluble.‡	P_2O_5 total.	K_2O.
	%	%	%	%
Loc. 957, Cowalla	12·8	2·5	15·3	1·9
Block 1102, Cowalla	10·5	4·7	15·2	2·0
C.G. 1110 East side Minyulo	8·5	4·4	12·9	2·0
C.G. 1110 West side Minyulo	6·7	5·6	12·3	?
Loc. 284, Koodiwoodi	13·2	1·0	14·2	?

‡ In dilute ($2\frac{1}{2}$E) nitric acid.

Between 1907 and 1909 H. Rowley, a consulting chemist in Perth, spent a great part of his time in experimenting with methods for converting the phosphates of these beds into a water soluble form with a view to using them elsewhere in the State as a fertiliser. His richest average rock only assayed 17.9 per cent. P_2O_5, and he did not apparently appreciate the fact that the first problem to be solved was the concentration of average rock assaying only 12.3 to 17.9 per cent. P_2O_5 to at least double that grade. Rock of such low grade would never pay to treat chemically in its original state, and even if the whole of its P_2O_5 was made water soluble the resulting fertiliser would be of too low grade to handle economically.

He took out four patents for chemical treatment of the rock, and applied for a fifth, but did not finalise it. His earlier patents involved a double melting of the rock with other salts and minerals, chiefly compounds of sodium and magnesium, and would have cost at least twice as much as the final fertiliser was worth. His last accepted patent, No. 15613, was for treatment of the very finely pulverised rock with a slight excess of strong caustic soda solution with or without heat. This process was subjected to extensive tests by Rowley himself, as well as by Dr. F. S. Carp and Mr. W. Moller, a European fertiliser chemist. The last named condemned the process on the grounds of high cost, as well as the low grade, variable solubility and alkalinity * of the finished product. Since Rowley's time no further effort has been made to commercialise the deposits.

It would seem as if the beds are of such low grade as to be valueless at present except for local use, unless further exploration should reveal richer concentrations of phosphatic material, or unless the beds, when followed under cover from the outcrops, exhibit harder pebbles in a softer matrix (as is quite possible), which would be capable of concentration by washing and sifting, as is done with the Florida pebble beds. This is a possibility well worth testing by means of a drive, which would also determine the thickness of the beds.

Meanwhile they have done good service in supplying the whole neighbourhood naturally with an abundant supply of phosphorus in the soil. This supply is many times greater than that which could possibly be added in the form of an artificial fertiliser, being anything from 2 to 10 tons per acre foot.

* Moller's figures show from 2·6 to 15·6 per cent. "free alkali," presumably calculated as caustic soda (NaOH).

E. A. Mann in another series of products found 1·2 to 23·4 per cent. NaOH.

Salt.—Many parts of the State are unfortunate in the possession of an excess of salt both in the soil and in the natural waters. Most useful plants are so easily poisoned by salt that no area can be too free from it so far as the healthy growth of pastures and crops is concerned. But districts like Dandaragan which are hilly and provided with a good rainfall are liable to have too little salt for the healthy growth of stock, all of which require a considerable amount to ensure perfect digestion and assimilation of food.

My visit to Dandaragan was made in the midst of the rainy season when it is impossible to get an accurate idea of the salinity of the soil and surface waters. This is best determined in the autumn.

Four samples of water were, however, obtained and analysed. One each from a well and a dam at the north end, and the same from central Dandaragan. The results obtained were:—

	Dams.		Wells.	
	Block 1178, Mungedar.	Block 833, Dandaragan.	Block 520, Mungedar.	Res. 18113, Dandaragan.
	Grains per gallon.	Grains per gallon.	Grains per gallon.	Grains per gallon.
Total soluble salts ...	7·00	28·0	11·20	21·0
Salt (NaCl)	3·71	19·2	5·53	5·7
Reaction	Faintly acid	Faintly acid	Faintly acid	Faintly acid
pH	6·3	6·0	6·4	6·0

All these waters are unusually fresh, rather too much so for stock. It is probable that all stock in the district would benefit by the regular provision of a salt lick, which should not, however, contain any phosphate.

Dandaragan Phosphate Deposits.
Outcrop of Phosphatic Pebble Bed on Block 957, near Cowalla Bluff.

Other Elements essential to Pastures and Stock.

Nitrogen.—No time was available to deal with soil nitrogen in detail. Of the two soils collected at Emu Hill and Mungedar homestead, the former was unusually rich in nitrogen, the latter of normal content. There was no visible evidence of

any lack of nitrogen in the pastures anywhere, and it was obvious that most of the soils contained abundant nitrogen-bearing humus, which was being constantly renewed by stock droppings, decaying herbage, and fixation of nitrogen by leguminous herbs.

Manganese and Copper.—Both of these are essential to vigorous plant growth and to the avoidance of anaemia in animals. As already stated above, a sufficiency of manganese was found to accompany the iron at Dandaragan almost everywhere it was looked for (see table below). No deficiency in that element is likely to occur except over the actual chalk outcrops.

Copper was determined in four specimens of phosphate rock, and found to range from 32 to 60 parts per million of rock, which is sufficient for all crop and stock requirements in the vicinity of these rocks. No figures are available as to its distribution in other rocks and soils.

Magnesium is only required in small quantities and is abundantly present in chalk, glauconite and clay beds, as well as in the natural waters of the district.

Iodine.—No survey of the distribution of this element, recently shown to be of great importance to living organisms, was possible in the time available. It is on record, however, that lime phosphate rocks from other parts of the world are comparatively rich in iodine, averaging 6 parts of that element per million. There is reason to believe that clovers and related plants are unusually rich in iodine, and wherever such plants are abundant and luxuriant no deficiency of iodine is likely to appear in stock.

Fluorine, an essential constituent of bones and teeth, is present in immense quantities in the phosphate beds, where it is a constituent of the easily decomposable mineral apatite.

Summary.

The Dandaragan district is an unusually fertile area provided with a good rainfall, and singularly free from any mineral deficiency (except possibly salt) likely to adversely affect either crops or herds. It is one of the very few districts in Australia which is abundantly supplied by nature with phosphates, not only evenly distributed throughout the soils and underlying rocks, but also concentrated in an extensive bed of phosphatic pebbles. No pasture dressing with artificial phosphates, nor provision of phosphatic licks to stock should be necessary.

The soils are also abundantly provided with potash and iron, owing to the wide distribution of glauconite, a somewhat unstable mineral which contains a high percentage of both elements.

Lime tends to be easily leached out of the soil, so that although a bed of chalk extends throughout the area, certain portions of it may require lime dressing from time to time, and for this the local chalk may be looked upon as an ideal material.

The apparent absence of salt is conducive to the development of luxuriant pastures, but salt licks appear to be necessary for the stock.

Commercial exploitation of the phosphate beds does not appear feasible from the outcrops, which are of too low an average in phosphorus, and are in such a physical condition as to preclude economical concentration. By further exploration, particularly into the hills under cover, beds may be found more amenable to treatment. They should be tested at two selected points by means of drives. Meanwhile they are a valuable reserve for local use in any intense culture.

Other commercial minerals worth further investigation are the glauconitic sands and the chalk.

Large areas of the district appear well suited for closer settlement, particularly in the form of small self-contained "mixed" farms, and orchards for the growth of warm climate fruit, such as oranges, passion fruit, grapes, etc.

TABLE I.

ANALYSES OF MATERIAL FROM PHOSPHATE BEDS, DANDARAGAN.

Parts per cent.

No.	ESS 3	ESS 12	ESS 13	ESS 22.	ESS 7.	WDC 6985.	ESS 16.	ESS 20.	ESS 28.	ESS 15.	WDC 6980.	WDC 6979A.	ESS 21.	WDC 6977.	WDC 6978.	WDC 6979C.	WDC 6979B.
Material	Siliceous Ironstone with Nodules.			Average of Nodules.	Phosphatic Ironstone.	Phosphatic Greensand.	Ferruginous sandstone with phosphatic nodules and phosphatised wood.			Phosphate Bed with little Dufrenite.			Phosphate Bed with much Dufrenite.			Clean Nodule.	Fossil Wood.
Locality	Jurien Paddock, North of Emu Hill.			Emu Hill.	Mungedar Homestead.	Mardo Tank.	Loc. 957, Cowalla.			Midland Block 1402, Cowalla.							
P_2O_5 sol. in dil. HNO_3*	...	2·14	·38	...	...	...	14·30	14·87	9·31	18·92	...	...	6·43	·06	..	...	...
P_2O_5 insol. in dil. HNO_3	...	1·94	·73	...	...	...	2·2	3·64	1·54	1·12	...	...	5·77	7·19	...	...	...
P_2O_5 total	1·60	4·08	1·11	25·26	1·27	2·10	16·52	18·51	10·85	20·04	15·32	18·26	12·20	7·25	9·63	26·26	38·80
CaO (Lime)	...	...	...	...	...	...	...	...	...	...	...	15·80	...	0·8	...	...	53·88
Fe_2O_3 (Iron oxide)	35·72	54·80	56·64	...	70·50	...	15·47	23·42	30·36	12·11	29·31	26·42	27·92	32·14	...	4·17	1·01
Mn_3O_4 (Manganese oxide)	Present	·13	·15	...	...	...	·013	·006	·03	·007	...	...	·014	...	...	...	·78
K_2O (Potash) acid sol.	...	1·02	...	...	·08	...	...	1·90	...	2·04	...	...	...	...	...	...	trace
Na_2O (Soda) acid sol.	...	·03	...	...	·14	...	...	·26	...	·20	...	...	...	...	...	...	trace
Siliceous Insol.	21·36	19·03	21·72	...	10·18	...	29·68	18·84	31·44	22·08	27·02	21·27	39·87	47·54	...	28·06	1·26
Ignition Loss	...	..	...	...	...	...	...	...	...	...	9·60	7·83	...	7·35	...	2·50	1·02
Al_2O_3 (Alumina)	27·05	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	trace
MgO (Magnesia)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1·17
CO_2 (Carbonic acid)	...	..	...	...	...	..	...	...	...	...	...	...	...	...	...	...	1·31
Fluorine	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3·00
Copper, parts per million	...	...	...	...	...	...	...	18	...	60	..	...	...	...	...	...	...

* P_2O_5 Phosphoric oxide. HNO_3 Nitric acid.

TABLE I. *continued.*

ANALYSES OF MATERIAL FROM PHOSPHATE BEDS.

No.	LG 2344.	ESS 24.	ESS 25.	ESS 14.	ESS 19.	ESS 18.	ESS 23.	ESS 17.	ESS 30.	ESS 26.	ESS 29.	Rowley 1.	Rowley 2.
Material	Phosphate Nodule.	Ferruginous sandstone with phosphatic nodules.		Pebble Bed with much Dufrenite.		Black phosphatic Ironstone.	Sandstone with Nodules.	Phosphate Bed.		Small Stinkstone.	Large Stinkstone.	Average phosphate Rock.	
								Irony part.	Limey part.				
Locality	Kayanaba	CG 1110 "Hole in the Wall," Minyulo.					West side of CG 1110.	Loc. 284, Koodiwoodi Ridge.				Cowalla or Minyulo.	
P_2O_5 sol. in dil. HNO_3	...	8·80	5·73	15·84	7·18	5·22	6·74	13·24	6·89	15·43	13·69	...	...
P_2O_5 insol. in dil. HNO_3	...	1·32	·92	2·67	6·29	10·92	5·56	·96	*nil*	*nil*	*nil*	...	...
P_2O_5, total	19·16	10·12	6·65	18·51	13·47	16·14	12·30	14·20	6·89	15·43	13·69	17·88	17·14
CaO (Lime)	...	...	...	...	...	...	...	...	...	...	...	...	11·70
Fe_2O_3 (Iron oxide)	...	25·85	47·03	26·21	27·82	41·66	31·54	16·89	3·77	...	...	...	20·70
Mn_3O_4 (Manganese ox.	...	·01	·03	·03	·01	·01	·09	·07	·03	...	...	...	...
K_2O. (Potash) acid sol.	...	...	...	3·38	2·33	·50	...	...	...	...	...	...	...
Na_2O, (Soda) acid sol.	...	...	...	·36	·78	1·14	...	...	...	...	...	...	...
Siliceous Insol.	...	37·67	26·40	29·67	33·90	19·76	31·77	25·56	23·79	48·10	54·74	28·04	...
Ignition loss	...	...	...	...	...	...	...	...	...	...	...	...	...
Al_2O_3 (Alumina)	...	...	...	...	...	...	...	...	...	...	...	...	...
MgO (Magnesia)	...	...	...	...	...	...	...	...	...	...	...	...	...
CO_2 (Carbonic acid)	...	...	...	...	...	...	...	...	...	...	...	...	...
Fluorine	...	...	...	...	...	...	...	...	...	...	...	...	...
Copper, parts per million	...	...	...	...	44	...	...	32	...	...	...	...	...

TABLE II.

ANALYSES OF ROCKS AND SOILS, DANDARAGAN.

Parts per cent.

No.	ESS 11.	ESS 10.	ESS 31.	JM 1.	ESS 6.	JM 2.	ESS 8.	ESS 4.	AFF 1067.	AFF 1070.	ESS 5.	AFF 1068.	AFF 1071.	AFF 1066.	AFF 1069.
Material	Chalk.		Glauconitic Clay below Chalk.	Sandy Ironstone.		Ferruginous Sandstone.		Rendzina Top soil.		Rendzina Sub soil.	Meadow Loam.	Meadow Top soil.	Meadow Sub soil.	Marri Forest Top soil.	Marri Forest Sub soil.
Locality	Emu Hill.	Kayanaba.	Emu Hill.	Jurien Paddock.	Mungedar H'stead.	Jurien Paddock.	Mungedar Homestead	Emu Hill.	Yatheroo.	Yatheroo.	Mungedar Homestead	Yatheroo.			
P_2O_5, total	1·12	·57	2·55	·91	·47	·14	·23	·364	·59	·37	·230	·07	·12	·06	·08
CaO (Lime)	34·82	30·29	...	...	...	...	...	16·89	25·04	51·72	·03	·04	·32	·24	·11
Fe_2O_3 (Iron oxide)	2·43	4·12	...	61·72	40·44	24·13	8·86	7·55	11·51	4·00	7·07	3·26	1·25	5·00	2·25
Mn_3O_4 (Manganese ox.)	...	...	...	Present	Present	trace	...	·003	...	...	·002	...	...	...	...
K_2O, (Potash) acid sol.	·08	1·08	1·59	...	...	...	...	·466	·70	·35	1·01	·18	·16	·06	·26
Na_2O, (Soda) acid sol.	·29	·26	...	...	...	...	...	...	...	...	...	...	...	...	...
Siliceous insol.	23·53	31·36	...	6·63	41·15	71·11	78·81	...	...	..	...	...	...	...	...
Ignition loss	·66	...	...	...	...	...	...	21·6	...	...	3·6	...	...	...	...
Al_2O_3 (Alumina)	3·13	3·83	...	17·00	...	·98	...	...	...	...	...	...	...	...	...
MgO (Magnesia)	1·31	·63	...	...	...	...	...	...	2·07	2·12	...	·09	trace	·07	trace
CO_2 (Carbonic acid	26·69	...	...	...	...	...	...	...	...	...	...	...	...	...	...
H_2O (Water)	5·32	2·58	...	...	...	...	...	...	...	...	...	...	...	...	...
Nitrogen	...	...	...	...	...	...	...	·406	...	...	·112	...	...	...	...
Cu, parts per million	...	...	...	...	...	...	...	6	...	...	9	...	...	...	...
pH	...	...	...	..	...	...	..	7·71	..	...	5·35	..	..	...	..
Reaction	..	...	...	.	.	.	.	Alk.	.	...	Acid	.	...		.

Table III.

MECHANICAL ANALYSES OF TWO DANDARAGAN SOILS.

Mark	ESS D4	ESS D5
Nature of Soil	Rendzina	Meadow
Locality	Emu Hill	Mungedar
	per cent.	per cent.
Coarse sand	10·6	37·6
Fine sand	21·0	45·8
Silt	4·4	2·6
Clay	25·7	10·0
Moisture	6·9	2·4
Loss on acid treatment	29·6	0·1
Loss on ignition	21·6	3·6
Calcium carbonate	22·8	*Nil*

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WEB-WORM

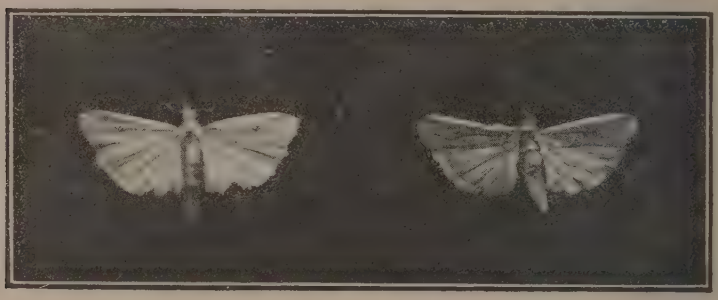
(*Sclerobia tritialis*).

By L. J. Newman, Entomologist.

There has been a considerable recrudescence this winter of the Web-worm (*Sclerobia tritialis*). In every instance the outbreaks have been on dirty stubble or grass lands turned in late. This pest is absolutely non-existent on fallowed country.

The parent moth of these Web-worms is a small, inconspicuous species. When at rest the wings are closely folded around the body, the colour of the wings closely harmonising with the dry stems of wheat or grass. From tip to

tip of outspread wings measures about one inch. The egges are tiny, round, pale yellow bodies, and are laid amongst grass and stubble. The parent moths issue after the first autumn rains and are naturally attracted to grass or stubble land. Fallowed land free of weeds or old stubble has no attraction to the moths.



Web-worm Moth (*Sclerobia Tritialis*).

Enlarged. (Orig.)

The eggs are turned in with the ploughing and sowing of the crop. If late ploughing, the eggs may have already hatched. These eggs or young caterpillars are not destroyed by the process of ploughing, and hence they attack the young wheat as soon as it begins to grow. The feeding capacity of these caterpillars in the early stages is not sufficiently great to retard seriously the growth of the crop. Later on, however, if the Web-worms are numerous, they cause very serious loss. The catepillars live within silken tubes, which they spin at the base of the plant attacked. They come out at night and cut off and draw the food into their tunnels and there consume it.

Larvae of Web-worm.

Enlarged. (Orig.)

This caterpillar does not migrate in armies as do the Army-worms, but take a crop of grass or wheat on a face. As they demolish one stool they move on to the next. Unfortunately there is very little second growth once this pest has been over a crop. This is due to the fact that the wheat plants are eaten down

below the crown. Several caterpillars may be found in a single wheat stool. This pest is troublesome to crops only when it outbreaks in a crop.

When fully grown the caterpillars pupate within their silken-lined tubes.

Native Grass cut down and destroyed by the Web-worm (*Solerobia Tritidis*). Note the entrance holes to the silk-lined tunnels in which the caterpillars reside. (Orig.)

Preventive measures. First and foremost aim at only cropping on fallow. Do not allow rubbish and weeds to accumulate. If not possible to fallow grass or stubble, lands intended to be sown to crop should be burned over. This will, if it is a good burn, remove much of the old grass and stubble, thus removing the natural attraction to the moths when they issue.

Examine crops at regular intervals and when patchiness is noticed investigate the cause at once. Look under clods, examine the base of the wheat stool, and if caterpillars of any description are found to be damaging the crop, take prompt action.

Remedial measures.—If caterpillars have broken out in patches, plough a sharp trench or ditch around each infested area. A coulter should be used in order that the edge of the furrow may be as sharp as possible. The sharp edge should be opposed to the advancing caterpillars. This trenching is only for the purpose of halting the advance of the Web-worms. **Poison baiting** must then be employed. The following bait has been found very effective:—Bran 30 lbs., Paris green or sodium fluoride 1 lb., molasses or treacle 4 lbs. The bran and the poison may be mixed in a dry form. The molasses is broken down with hot water, until of a thin consistency. This is then stirred into the bran and poison and mixed to a moist crumbling state. The bait is then broadcasted amongst the caterpillars as late in the day as possible. This mixture is very attractive to the caterpillars when they crawl about in search of food. Spread the bait as thinly as possible, avoiding wet lumps.

If caterpillars still persist, it will be necessary to make a second and perhaps a third application at intervals of three to five days.

Crop that has been so badly attacked as to be worthless, should be fallowed as soon as possible.

DUST IN OUR AGRICULTURAL WOOLS.

Hugh McCallum,
Sheep and Wool Inspector.

The damage done to wool by the unnecessary exposure of sheep to dusty conditions can with a little forethought be considerably minimised throughout the Wheat Belt.

Undoubtedly on a wheat and sheep farm, when the fallows are being fed off from time to time, they become more or less dirty with various weeds. Very often little attention is given to sheep at the time they are being shorn to prevent the sheep from raising dust; unnecessary yarding and driving sheep across fallow instead of going around same will raise dust that will penetrate to the skin and remain to form the tip of the staple. The dust absorbs the natural grease which is needed for the healthy and sound growth of the fibre, and spoils the appearance of the wool. The tip of the wool becomes dry and wasty, resulting firstly in a heavy loss in scouring owing to the quantity of dust. This waste can be eliminated to a great extent by allowing the sheep as much spread as possible when mustering or droving. Constant rounding of the sheep by dogs stirs up dust and works it into the staple.

The less dust in wool from our sheep farms, the better price per pound for the clean and bright wool. Every particle of dust which adheres to the fleece reduces its yield and detracts from its appearance. Wool clips that are bright and clean attract the buyer's eye, especially since one of the factors influencing his purchase is the percentage of clean yield. The care of sheep and the prevention of dust gaining admission, when it can be avoided, from shearing to shearing, will greatly assist in obtaining higher prices for the clip.

On many stations and farms it is the practice to water the yards at intervals to keep down the dust. Such a sound and inexpensive method might well be adopted wherever practicable.

OBITUARY.

The Department of Agriculture, as well as the State, has suffered a severe loss in the decease of two prominent citizens in the persons of Mr. C. J. Craig, Chief Inspector of Rabbits and Vermin, and Mr. E. J. Limbourne, Cereal Breeder of the Merredin Experiment Farm.

The late Mr. C. J. Craig was first employed with the Department in 1902 when the Rabbit-Proof Fence was commenced. It was then found that rabbits were beyond the fence line and the services of experienced and qualified men were sought to cope with the invaders, and it was in this capacity that Mr. Craig found employment. Towards the end of 1904 his ability to impart instruction to others, coupled with the success of his own efforts, gained for him official recognition and caused him to be singled out to take charge of the northern section of the No. 1 Rabbit-Proof Fence when it was completed by the

The late Mr. C. J. Craig.

Public Works Department. He remained thus in charge until 1914 when, on account of the increase in rabbits in the settled areas, he was transferred to Head Office as Rabbit Inspector, a position which he retained until 1924, when he was advanced to that of Chief Inspector, occupying this position with signal success until the time of his death. He had a lifelong experience of rabbits and the various animal pests which affect the pastoral and farming community, enabling him to impart necessary advice to all inquirers, and his unfailing courtesy was appreciated by all who met him.

Mr. E. J. Limbourne came to this State in January, 1912, from Birmingham, England, and shortly after the outbreak of the Great War enlisted with the 44th Battalion, seeing active service on the Western Front, where he was badly gassed. Invalided home in 1918 he joined the staff of the Merredin Experiment Farm in November of the following year, where he was associated with the work of cereal improvement, being subsequently appointed to the position of Cereal Breeder. Possessed as he was with a natural ability in this direction, and a capacity for detail coupled with a keen sense of observation, it is not surprising that in the space of 13 years he achieved great success. Amongst the more

The late Mr. E. J. Limbourne.

important of the achievements to which his enthusiasm largely contributed, were the development of the Bencubbin and Totadjin varieties; both flag smut resistant and high in productivity. It is probable that these varieties may yet become the most widely grown in the State and Commonwealth. Noongar, the earliest maturing variety under cultivation, came as a result of his labour, and several cross-breeds which we hope will yet add considerably to the wealth of our agricultural industry. Maintenance and improvement in type and productivity of the standard varieties produced for pedigree seed at the Merredin Farm also claimed his attention, and the value of such seed is now universally recognised by the farming community.

Mr. Limbourne was a frequent contributor to this Journal, his articles being informative, clear and lucid. He contributed as well to the Journal of the Royal Society of Western Australia, in association with Mr. W. M. Carne, a paper on the occurrence of natural crossbreds in oats and barley.

A member of the local Agricultural Society, the R.S.L., and Toc H., he carried with him a characteristic thoroughness of purpose, though of a quiet and unassuming nature. He was of unswerving loyalty to his friends, and during the latter years of his life his fortitude and determination when faced with declining health, as a result of his war injuries, were an example to all. His work will be long apparent, and his memory cherished by his fellow officers.

To the bereaved of both these men we extend our heartfelt and sincere sympathy.

HORTICULTURAL NOTES.

Geo. W. Wickens,
Superintendent of Horticulture.

Once again fruit trees and vines are rousing from their winter resting period, and are decking themselves in spring attire preparatory to commencing the important work of fruit production in the ensuing summer, and growers whose livelihood depends upon the resultant crop watch the changing beauty of young buds to bursting blossoms and tender green growths with mixed feelings of appreciation, apprehension and hopefulness, appreciating the beauty, fearing that some untoward circumstance may prevent fruition, but hoping that good fortune will attend, and the crop be a bumper one. Only those who have been intimately acquainted with the expectations and disappointments associated with deriving a living direct from the produce which Mother Earth can be coaxed into yielding, know the anxiety at this time of year connected with the thoughts of—"What will the harvest be"? No one is well equipped for the business of growing fruit unless he has an abundant capacity for faith, hope and work, and though work is the essential one of the three, it becomes impossible without faith in its performance, and hope for profitable results.

So far as orchards and vineyards are concerned, there is no period of the year when it is hard to find a job requiring immediate attention; but if there is one season more stressful than another it occurs during spring and early summer, when ploughing, manuring, cultivating, hoeing, spraying, thinning, grafting, budding and a long list of etceteras all call for action, and the work entailed must be carried out to a rigorous time-table set by the exigencies of the season, necessitating on the part of the man on the land not only a capacity for work, but method in handling it, so that each activity is attended to at the proper time.

Spraying pear trees to control scab—*venturia pyrina*—is an operation which, if not done at the correct time, no amount of work at a later date will give satisfactory results. Pears sold well on the London market, both this year and last, and in both years considerably more would have been available for shipment if scab had not injured the fruits. This disease has been so long with us that I think the methods of treatment are well known by all growers, but if there are any who are in doubt, and they write to this Department, a leaflet by the Plant Pathologist, Mr. H. A. Pittman, containing full information, will be posted.

Fruit Fly is still with us, and though large areas of orchards in the South and South-West remain free, a considerable toll is taken annually in places within 60 miles of Perth. Constant attention in gathering and destroying all infested fruit from the trees and ground, in addition to trapping and baiting, will hold the pest in check and prevent serious losses, but the work in this connection must be carried out with the regularity and constancy of the operations on a well-conducted dairy farm, or the pest will gain control instead of the orchardist.

In citrus groves orange aphis will require spraying where it is sufficiently numerous to destroy the blossoms. Black Leaf 40, or similar nicotine sprays, are effective, but the pest often re-appears, and more than one application is then necessary.

Red Scale is one of the worst scale insects that prey on citrus trees, but, fortunately, it is largely held in check by parasites in Western Australia. Occasionally, however, the pest increases sufficiently to cause damage, and when this occurs the worst infested trees in the orchard should be sprayed, leaving those less heavily attacked to carry on the parasite. As evidence of the good work that has been

performed by these beneficial insects. I may mention that for many years past no regular spraying nor fumigating has been done in the great majority of our citrus orchards, but Red Scale is now far less in evidence than it was at the time when annual treatment was necessary.

Fortunately, no sign of apple scab was found this year in the two orchards one at Manjimup and one at Porongorups where the disease was found two seasons ago, and it looks as though Western Australia is again free from this scourge of the apple grower.

Codlin Moth, also, has made no appearance for two years, and as this has obtained without any control treatment being carried out in any orchard during that period, it is safe to say that Western Australia is again free from the pest until such time as it once more finds an entrance from outside.

Vignerons are not without their disabilities in the shape of diseases, Anthracnose and Oidium being amongst those that require attention, the former now, and the latter later in the season.

Thinning of all kinds of fruit is an essential orchard operation that is often sadly neglected, yet there is no other that pays better. A leaflet on the subject can be obtained at this Department.

I have not dwelt in these notes on the methods of carrying out the various operations, either cultural, spraying, grafting, or budding, etc., referred to in the commencement. To do so would practically mean a treatise on fruitgrowing, but in each district there is an orchard supervisor who is only too willing to advise on any subject connected with the industry, and it is hoped that orchardists generally will fully avail themselves of this service.

In conclusion I would like to express my hope that the promise of spring will be followed by an abundant harvest and payable prices.

"TOXIC PARALYSIS" OR BOTULISM IN SHEEP AND CATTLE.

A. McK. CLARK, L.V.Sc.,
Chief Veterinary Surgeon.

The attention of sheep and cattle owners is drawn to the presence of this disease, which is the cause of serious mortality amongst their flocks and herds during the summer months. It is especially in evidence in the Wheat Belt. The losses are considerable, and it may even be said that toxic paralysis takes the greatest toll of all diseases during the year. The purpose of this article is, therefore, to give due warning to those owners whose sheep and cattle have been, or may be, affected with this troublesome disease in order that steps can be taken to prevent losses from this cause during the coming summer. The reason for toxic paralysis becoming more evident last summer is attributed to the following reasons:—

(1) Long dry summer—(Lack of minerals in pasture).
(2) Lighter distribution of superphosphate—(Less mineral in the soil).
(3) Greater number of dead rabbits—(Infected carcases available for ingestion).

Causes.—This disease is prevalent in many of our districts amongst cattle owing to a mineral deficiency in the food supply. Milking cows in particular constantly require supplies of phosphate in order to remain healthy. Cattle will

attempt to make good their mineral requirements, when pastures are deficient, by chewing bones, which are rich in the necessary elements. If mineral deficiency is very marked the animal's appetite becomes more and more depraved, with the result that all kinds of rubbish is eaten. There is in most districts a germ (*Bacillus botulinus*) which occurs in the soil and infects carcases of animals—cattle, sheep, rabbits, etc. It is found, and, by reason of its great resisting powers, may remain for considerable periods, in bones of dead animals. This bacillus or germ produces a powerful toxin or poison. When the bacilli or toxins are ingested (with bones or parts of carcases which are infected with them), particularly by cattle, in the great majority of cases fatal results ensue. Carcases of animals which have died from the disease are, of course, very dangerous. The disease produced is sometimes known as "Dry Bible" or "Toxic Bulbar Paralysis."

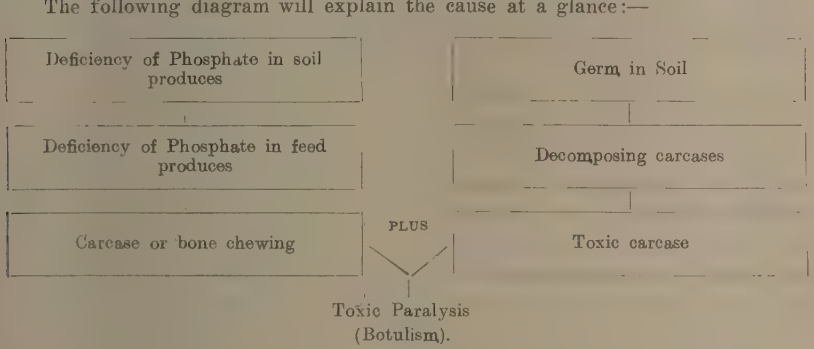
The rabbit carcase-eating habit is developed in sheep owing to continued feeding during the long dry summer on stubble and other pastures which are deficient in phosphates. It will not become evident in the winter months, but usually in the middle or end of the summer.

In order that this disease may occur on a property two factors are essential—

(a) Mineral deficiency.

(b) Presence of bacillus botulinus.

The following diagram will explain the cause at a glance:—



SHEEP.

Symptoms.—Sheep mostly affected are young sheep and in good condition. In some cases the initial symptoms appear to be wriggling of the tail as though fly-blown. Later they show a stiff gait and a disinclination to move, progressing only for a short distance and then lying down. The animal appears dull and does not attempt to eat. When standing, the head is held in a drooped position, frequently with the lower jaw hanging down. From the open mouth a more or less profuse flow of saliva occurs. In advanced cases respiration is spasmodic and abdominal. Finally the animal is unable to rise, and dies quietly without a struggle. The mortality is usually in the vicinity of 10 per cent.

Prevention (Remedying deficiency).—Cure by treatment is not known, therefore preventive measures, which are known to be successful, should be adopted. It is essential that the full mineral requirements of sheep during the summer months be supplied in order that the craving for rabbit carcases and other debris be satisfied. It is estimated that the optimum daily intake of phosphoric acid for two-tooth ewes weighing 80 lbs. is about $\frac{1}{8}$ oz. For 100 sheep for a week this

would be 5½ lbs. The amount of phosphoric acid which 100 sheep would obtain, in one week, from our summer pasture, is about 3 lbs., and in parts of the wheat belt may be even less. This leaves a deficiency of 2½ lbs. of phosphoric acid. This would be provided in 14 lbs. of dicalcic lick having an 18 per cent. phosphoric acid content. This should, therefore, be taken as a minimum amount of lick to be provided in the wheat belt. That is approximately ⅜ oz. of dicalcic lick containing not less than 18 per cent. phosphoric acid per sheep per day.

Oats.—Oats are often fed to sheep in this State, and it is interesting to note the phosphoric acid content of this important feed. 1,000 lbs. of oats contain 8 lbs. of phosphoric acid. If oats are fed at the rate of 1 lb. per sheep per day they will supply in one week to 100 sheep about 5½ lbs. of phosphoric acid; this is the required amount of minerals.

Licks.—The question is, therefore, "What lick to use?" It has already been pointed out that this should be a *dicalcic lick containing not less than* 18 *per cent. phosphoric acid.* Bone meal has been used with success for this purpose, but it has been shown by recent investigations that dicalcic phosphate, weight for weight, is three times as effective as bonemeal. Therefore dicalcic phosphate is the most economical and efficacious mineral to use as a lick for the purpose of supplying the necessary minerals to sheep in order to prevent that craving for carcases and debris, and consequently prevent infection with the germ which is the direct cause of toxic paralysis. It is recommended, therefore, that sheep on the wheat belt be supplied with a lick, during the summer months, which can be made up as follows:

Commercial dicalcic phosphate	45 parts.
Commercial Salt	40 „
Molasses	5 „
Water to condition	10 „

In addition, of course, all rabbit carcases and bones should be collected and burned or buried deeply.

This lick is odourless and devoid of any taste and its purity is unquestionable. It should be supplied in wooden containers and placed near the water supply. If sheep are unaccustomed to licks, care should be taken to make them familiar with them. Should they disregard them the addition of a little oats or wheat germ will attract them. This may be excluded after the sheep take freely to them. It may even be necessary to yard the sheep at night, at the same time placing the licks in the yard with them. Phosphatic licks should not be taken away from sheep as a matter of course at the beginning of the winter, but should be continued until the sheep refuse to take them. In all cases they should be made available each year not later than September. It must be pointed out that where toxic paralysis is prevalent amongst sheep a lick containing not less than 12 per cent. phosphoric acid would be necessary in most cases. Also that because licks are taken freely is no indication as to their efficacy.

Other Beneficial Effects.—Apart from the losses sustained by sheep contracting toxic paralysis through the ingestion of infected material, a lack of phosphates in the food supply decreases the food consumption, with the result that an economic loss ensues through the sheep not making the best use of the available pastures.

CATTLE.

Symptoms.—Dairy cows are particularly affected, whilst depasturing; cattle during the summer months are affected to a lesser extent. Cows at the height of milk production require large quantities of minerals for milk secretion. The symptoms produced are due to paralysis of certain portions of the nervous system by

the toxin (or poison) of the invading bacillus. In typical cases the animals are unable, or with difficulty, to masticate or swallow feed. In the early stages there is difficulty in drinking, later no feed or water is taken. There is excessive salivation and sometimes protrusion of the tongue. The gait is more or less staggering (partial paralysis), and the animal is dull. Rumination (cudding) is disturbed and finally suspended, and the faeces are scanty. Progressive weakness ensues, the animal lies down and can be got to rise only with difficulty or not at all. Eventually, in from two days to a week after symptoms are first noticed, the animal sinks into a state of coma (sleep) and dies. These characteristic symptoms are not always shown. In very acute cases death is sudden; other cases may be of longer duration than described, the affected animals showing general unthriftiness, loss of condition and a cripply gait. The bone-chewing habit is constant in all cases.

Prevention.—As treatment is of no avail, preventive measures should be adopted. In mild cases assistance can be given by giving a drachm of powdered Nux Vomica in the food supply three times daily. Drenching should not be attempted owing to the inability of the animal to swallow and the consequent possibility of choking.

Licks.—Prevent mineral hunger and the consequent depraved appetite by supplying phosphates. Bonemeal has been successfully used in the past but a cheaper substitute is now recommended, known as dicalcic phosphate. The latter is three times more effective in similar weights as bonemeal. Dicalcic phosphate should be given in quantities of 2 oz. per cow per day in the food supply, or in the form of a lick which is made up as follows:—

Commercial dicalcic phosphate	45 parts.
Commercial salt	40 „
Molasses	5 „
Water to condition	10 „

In the event of this lick not being freely taken by cattle, a little linseed meal should be added only until the necessary liking is developed.

All carcases and old bones should be removed from the paddocks which are carrying stock and buried deeply, or preferably burned.

MAIZE—THE KING OF FODDER CROPS *

Geo. L. Sutton,
Director of Agriculture.

The maize plant has been described by Henry as "The Imperial Agricultural Plant of America," and in that country it is certainly the "King of Fodder Plants."

Under suitable conditions and when sown thinly a heavy crop of grain is produced, and when sown thickly little grain is produced but a heavy yield of succulent fodder is obtained, and this can be made into bright and nutritious but coarse hay or the best of silage. Even the stalks from which the grain has been removed have a feeding value of about one-third the total food value of the whole crop at the time of removal. The stalks from which the cobs have been removed are known as "Stover" in distinction to "Fodder" maize, which applies to the stalks either green or dry, and from which the grain, if they carry any, has not been removed.

* Reprinted and revised from the article with the same title published in the Journal of Agriculture, W.A., September, 1924.

In the Dairy Belt there is ample room and need for rapid expansion of the cultivation of the maize plant as summer fodder. This is specially valuable, for it provides the means by which the dairy farmer can ensure adequate supplies of succulent fodder during the dry summer months, and further, it is complementary to the clover hay which can be so readily produced and conserved. On non-irrigated land it is reasonable to expect, with good cultivation, from 9 to 15 tons per acre. In the crop competitions conducted by the Department of Agriculture on such land the yields of fodder maize ranged up to 19½ tons per acre. Fodder maize, by supplementing the grazing on established pastures during the summer months, provides a means whereby progressive dairy farmers may increase the carrying capacity of their holdings.

The whole of the plant is useful for stock food—no part except the roots need be wasted. It can be used at any stage of its growth, but supplies the maximum amount of food material when almost mature ; at this stage it furnishes a very large quantity of greenstuff suitable for the bulky part of the ration for dairy cattle or idle animals.

The maize grain when ripe furnishes a concentrated stock food, hard, rich in starch and oil for producing heat and energy, and therefore admirably suited for hard-working animals, especially in winter. The grain is comparatively low in protein and ash, and is therefore not suitable for feeding alone to young animals and milking cows ; if it is to be used for this purpose it requires to be mixed or balanced with foods rich in protein like clover, lucerne, linseed cake, or bran. Broadly, there are three colour types of grain, viz., *Yellow*, *Red*, and *White*. This difference in colour may on occasion have an important bearing upon the nutritive value of the respective types on account of their vitamine content. All types are fairly rich in vitamine B, but coloured maize grain contains in addition the vitamine A. It is essential, therefore, that animals which are being fed on white maize should also receive as part of their ration some food containing vitamine A, as milk, lucerne hay, or green fodder, or pasture of some kind.

The maize plant is botanically known as Zea mays —hence the common name "maize" by which it is known in this State. It is a native of the warmer parts of Central America, and in that country is usually referred to as "Corn," just as wheat, the staple grain of Britain, is also known as "Corn." To distinguish it from wheat, where there is likely to be some comparison between the two grains, it is called "Indian Corn," the term "Indian" being used because the early American settlers and explorers found the American Indians cultivating this plant, the grain of which was used by them largely as Europeans use wheat.

The maize plant grows to a height of from two to 18 feet, according to variety and conditions of soil and climate under which it is grown. The stem or stalk has joints or nodes like the straw of wheat and oats, and this when mature has a pithy interior, which is covered with a thin layer of hard glossy material. Broad succulent leaves are found growing along the stem, a single one growing from each joint. The stalk as it reaches maturity ends in what is known as the "tassel," and this is the male portion of the flower. The other portion of the flower is known as the "silk," and consists of a mass of fine silk-like hairs enclosed in a covering known as the "husk," and in which the grains produced are formed. The "silk" being located below the "tassel," the pollen of the latter is blown about in the air so as to provide the opportunity for it to fall on the "silks," and if the conditions are favourable these are fertilised. Each silk extends back into the husk and to what will eventually become a grain of "maize" if fully fertilised. The grains when developed are arranged around a cylindrical central portion known as the "core" or "cob," and this with the grains attached is known as an "ear" of maize. A badly fertilised "ear," which has only a few grains on it, is known as a "nubbin."

Varieties—The number of varieties of maize is almost legion. From the farmers' standpoint they differ mainly in their period of maturity, their vigour as represented by the height of the stalks, and in the colour of their grain—white, red or yellow.

Experience in this State indicates that early maturing varieties have been found to be most suitable for our conditions, and "Hickory King," with white grain, and "Leaming," with yellow grain, are recommended.

Climate and Soil.—The maize plant, being indigenous to the warmer parts of South America, thrives best under warm moist conditions, and, as might be expected, it is killed by frosts. It will resist drought, however, if the ground is in good condition and well cultivated between the plants until the tasselling period. The experience already gained in this State conclusively demonstrates that it can be grown in the Dairy Belt.

The most suitable soil for maize is a deep sandy loam well charged with organic matter, such as is found in alluvial flats along river banks, and at one time it was considered that maize could only be grown profitably on such soils. It has been found, however, that new and improved varieties, *e.g.*, Hickory King, already referred to, will grow on a variety of soils, and on those which at one time were regarded as quite unsuitable, provided the land is thoroughly prepared, suitably manured, and the soil between the plants properly cultivated during the growing period.

For the production of grain the critical period is the tasselling stage, and favourable weather and abundant moisture at this time are essential for heavy grain crops. In districts with a limited summer rainfall these conditions are ensured by means of irrigation or by the selection of land known as "summer" or "moist" land, and which has subsoil moisture within about one to two feet of the surface. An irrigated crop is shown in the illustration herewith. It was grown by Mr. E. Forrest, Picton House, near Bunbury.

Preparation of Seed Bed.—Maize is deep rooting; the soil should therefore be deeply prepared; on average soils the depth ploughed should not be less than five inches and may reach eight inches. It should be *thoroughly* done, for no amount of cultivation after the crop is up can compensate for the lack of thorough preparation. If possible the ploughing should be done some time before the planting so as to give the soil opportunities to mellow. This is particularly so in the case of heavy clay lands, which will benefit considerably by being exposed to the action of frost during the winter. After ploughing the ground should be brought to a fine tilth by the use of harrows, including the disc harrow, if necessary, to deal with and pulverise pasture land. If the ground is at all cloddy the lumps will require to be broken with a roller or clod crusher. This latter can be made by bolting three of four two-inch planks about five feet long weatherboard fashion on to bearers. On loose sandy land the roller will be useful for compacting the seed bed.

Planting Period.—The time for planting will depend upon the climate of the district in which the crop is to be grown, as maize will not stand frost. It should therefore be planted late enough to escape late frosts in spring and early enough to miss the early frosts in autumn. In the main part of the dairy belt the month of October will be found safe for early planting, and at the Denmark Stud Farm it has been found practical to plant as late as January for maize for silage—the usual planting date for the silage crop being the first week in January. Between these two dates there is a wide range for planting at intervals to secure a succession of green stuff for dairy purposes. It is anticipated, however, that November will be found the most suitable month for the main planting throughout the Dairy Belt.

Seed Selection.—At one time it was thought that grain from the middle of the cob was better for seed purposes than that from the pointed end or "tip," or from the "butt," *i.e.*, the end to which the husk is attached. Numerous experiments however, have shown that, as far as the resulting yield is concerned, it is immaterial from which part of the cob the seed is taken. That from the middle, however, has the advantage that it is more regular in shape and size, and, therefore, more suitable for machine planting.

Seed maize sometimes carries in it the mycelium of a fungus disease known technically as *Fusarium* sp. or *Diplodia* sp. and popularly as the "Seedling Blight" of Maize. It is so-called because its effect is to cause the seedlings to blight or wilt off. Some plants, after being attacked, may survive and reach maturity but they are always weak. Unfortunately, there is no known method of control which is readily available to local growers for treating the seed, and the only preventive is to secure seed from crops which have not had the disease. Such seed will only be available when growers generally create a demand by asking for it. When known non-infected seed is not available, the means to combat this disease are thicker seeding in the row or hill and the maintenance of high soil fertility supplemented by liberal manuring with superphosphate.

Irrigated Maize, Picton, W.A.

Treatment of Seed.—Sometimes birds, *e.g.* crows are troublesome and follow the drill marks and pull up the seed after it is planted. To prevent this the seed is coated with coal tar by pouring coal tar over the grain at the rate of one pint to the bushel, and then stirring it with a stick until the grains are evenly covered. When covered they are dried for planting by mixing with sand or ashes. Seed disinfection with organic mercury compounds, such as "Bayer dust" and "Improved Semesan Junior," has given good results in controlling many seed-borne diseases in the United States of America, but unfortunately these substances are not at present on the market in this State.

Rate of Seeding. The practice of sowing maize broadcast is almost universal in Western Australia. Such a method is, however, no longer in accordance with

modern practice in the Eastern States and the United States of America, and it is desirable that it should be discontinued here, even when intended for fodder purposes only.

Maize intended for grain is planted in either drills or "hills"; under the former method the single plants are grown at regular intervals in rows, under the latter two or more seeds are planted at regular intervals in rows in holes or "hills." It has been found inadvisable to have more than four plants in a "hill," and the common practice is to have three. Experiments have shown that there is little or no difference in the yield whether maize is planted in "hills" or drills.

The "hills" are said to be checked when the hills are in lines across the rows as well as in the rows, just as in many orchards the trees are in lines in two directions, one at right angles to the other. The checked hill method has the advantage of allowing the land to be cultivated two ways, and thus facilitates the destruction of weeds in dirty paddocks. To enable the proposed crops to be planted according to this system, special appliances called "check row" attachments have been devised for use with double-row planters. When a machine-planter with such an attachment is not available, a common plan is to strike out furrows across the length of the paddock the distance the rows are intended to be, and then plough out other furrows running across the width of the paddock, and sow the seed (say four grains) where the furrows intersect one another.

Great variation has been obtained in America and Eastern Australia with regard to the number of plants to the acre, and has ranged almost all the way from 5,000 to 50,000 per acre. The drills have varied from three to five feet apart, with single grains one and a-quarter to four feet apart in them. The closer distances usually give the greatest yield of food material, but with smaller cobs and more "nubbins." When the crop is grown for grain the husking of the smaller ears increases the cost of harvesting, and so the happy mean between high yield and low cost of husking is sought.

There will always be some variation in the number of plants per acre necessary for best results, on account of the difference in varieties and climate. As the result of many experiments the tendency now, however, is to maintain a uniform distance between the drills about 40 inches, and to vary the distance between the plants in the drills. It is believed that under Western Australian conditions maize planted in drills about three and a-half feet apart with single plants 12 to 15 inches apart will give best results for grain, and with plants four to six inches apart best results for fodder or silage. At these distances the amount of seed required per acre will be:—for fodder or silage, 14 to 18 lbs.; for grain, six to eight lbs. If planted in "hills" it is recommended that the "hills" be three and a-half feet apart each way, with three grains to the hill.

Depth of Plant "Listing."—Maize being a large seed, quite a considerable percentage will grow if planted four and five inches deep, but from two to three inches deep is considered the best depth to sow. It throws out brace or secondary roots as well as primary ones, the object being to resist the effect of heavy winds on such a tall plant. It is considered desirable to have these roots well below the surface, and it may be thought this can be accomplished by planting deeply. This, however, is not so, for no matter how deep the planting, the secondary or brace roots will grow just below the surface, whether planted as deep as six inches or as shallow as two inches. To overcome this characteristic the practice of planting the seed two inches deep at the bottom of an open plough furrow, and then to fill in the furrow by successive cultivations as the plant grows, is sometimes adopted. This method is known as "listing." It is claimed by its advocates that a "listed" crop will stand drought better than one planted on the level. Sometimes such a method is necessary during a dry spell in order to reach the moisture necessary for

germination. This was the case at the Denmark Farm last season, and as a result it was practically the only crop fit to harvest in the district owing to an abnormally dry summer.

Maize Planting Machine.—Single and double row maize machines for planting are now available. They are expeditious and do extremely satisfactory work. They are designed to sow the seed in "hills" or single grains at regular intervals, and with suitable plates can be used to sow seeds as small as turnip seed or as large as French beans. They are also fitted with an attachment for applying the fertiliser, and with a device for marking out the line for the driver to follow when planting the next row or rows. These machines open the furrow, drop the seed, cover and press the seed into the soil in one operation. This last operation of pressing the seed into the soil is of considerable importance, and is done by the rear or driving

Single row Maize Planter.

wheel, which has a concave surface. The best machines have what may be described as a "split" covering wheel, that is, the iron rim is in two pieces with a space of about three-quarters of an inch between each side. If the surface of the covering wheel is unbroken all the soil above the seed is compacted or firmed, whereas if there is a space between the two edges the soil immediately above the grain is loose, and does not become badly crusted if rain falls before the seed shows above the ground.

Because of the importance of pressing the seed into the moist soil, to assist germination, hand planted seed should be pressed with the foot as it is dropped.

Single row planters can be drawn easily by one horse, but when the machine is used with the marker on, it runs more smoothly and is less strain on the driver if a pair of light horses are used. About seven acres is a fair day's planting with a single maize planter with drills three and a-half feet apart.

Manuring.—Unless it is intended to replace all the plant food removed by the crop, the system of manuring will be governed to some extent by the character of the soil on which it is grown, for under other conditions the farmer will desire

to utilise some of the latent fertility of the soil. As a guide to what may be expected in this connection it may be stated that sandy soils are deficient in practically all the elements of plant food and peaty or swamp soils deficient in the mineral constituents (phosphoric acid and potash), whilst clay soils are usually well supplied with potash.

Because of the large tonnage produced, a crop of fodder maize removes from the soil a very considerable amount of plant food. A 10-ton crop, which is only a fair one, will remove about 80lbs. of nitrogen, 30lbs. of phosphoric acid, and 70lbs. of potash. Of these constituents nitrogen is much the most expensive, relative rates per unit being: nitrogen 12/6, phosphoric acid 4/2, potash 7/4. *To suplpy the whole of the quantity of nitrogen required by means of commercial fertilisers is economically impossible. Fortunately it can be supplied indirectly and without cost by sound farming methods, as the result of growing a legume, *e.g.*, subterranean clover, to precede the maize crop, for legumes have the ability to collect and store up this valuable plant food from the free nitrogen present in the air. Subterranean clover is a legume, and grows most luxuriantly throughout the Dairy Belt. It should therefore become an established practice to arrange that the maize crop follows clover pasture after the second or third year, though this is not so necessary in peaty soils. When maize is to succeed clover the land should be ploughed up sufficiently early in the winter to enable the clover roots and stubble to become partially decomposed and incorporated with the soil before the maize is planted.

Farmyard manure or any coarse manure can be applied with very great advantage and in any quantity with perfect safety to this crop. There is no danger of heavy dressings injuriously affecting maize, as would be the case if applied to the wheat crop in the Wheat Belt. Nor is there any need to wait until it rots before spreading it on the land intended for maize, for the cultivation which must be given the maize crop will destroy the weeds which may grow from the unrotted manure. It can be spread with advantage on the subterranean clover or legume sod as fast as it is made and ploughed in at convenient times. The maize plant, because it is a gross feeder, can make use of the coarse unrotted manure, and it is assisted in this direction by the fact that it makes most of its growth during the summer when nitrification and other natural agencies are most active, and in consequence a larger proportion of the plant food constituents are made available than would be the case if the crop were grown in the winter.

Because of their usual deficiency in phosphoric acid, it is probable that on all our soils it will be advisable to supplement the application of stable manure, and the plant food accruing from the turning in of the clover sod with an application of superphosphate, and on sandy and peaty swamp soils with some potash.

Pending the securing of definite local information regarding the crop requirements under our conditions of soil and climate, it is recommended that the fertiliser used on clay and alluvial soils which are usually well supplied with potash be 2½ cwt. of superphosphate per acre. On sandy, peaty and swamp soils, which are usually deficient in potash, an addition of ½ cwt. of sulphate or muriate of potash per acre to the superphosphate is also recommended. If the maize be planted on land other than peaty or swamp soil which has not had subterranean clover or other legume preceding it, it will be advisable to add at least a half cwt. of sulphate of ammonia per acre to the above fertilisers. With this latter addition the fertiliser will be of similar composition to the Potato Manure E put up by the fertiliser firms.

* A fertiliser unit is 1% or 1/100th part of a ton and is, therefore, equal to 22·4lb.(nearly 22¼lb.). Just as a stone of 14lb. is a conventional term used in connection with the sale of potatoes, so unit is a conventional term used to facilitate easy calculation when reducing the prices of fertilisers to a common basis for comparative purposes.

The fertiliser can be applied at the time of planting, but as it is risky to have potash fertilisers in direct contact with the young rootlets, provision should be made to prevent this either by stirring the fertiliser into the soil before the seed is planted or by some other method.

Cultivation after Planting.—Much if not the whole of the success which will attend the cultivation over a large part of the Dairy Belt will depend upon the cultivation given to the soil after the crop is planted. A huge crop—up to 20 tons—which the maize plant is capable of producing in a short time, requires a considerable quantity of moisture and plant food. By cultivating the soil between the rows of plants, the weeds which would rob the maize of both moisture and food are destroyed, the moisture is conserved by reducing the loss resulting from evaporation, and the soil is aerated and the natural agencies stimulated to make plant food available. Realising these facts, it can be readily understood how important a part "intertillage"—or cultivation between the drills—plays in the production of this crop, and especially where the summer moisture is limited. It may

Single row Maize Cultivator.

be advisable to cultivate the soil before the young plants have appeared above the ground, if warm rains have occurred and the weeds are germinating rapidly. Such instances are likely to be rare. Almost invariably, however, it will be found that intertillage is desirable as soon as the rows of plants can be seen, and this should be continued as often as may be necessary to keep down weeds and maintain a loose layer—a "blanket mulch" of earth on the surface.

The cultivations should begin soon after the seed is sown and continue until nearly as high as a man's head. A light spike tooth harrow can be run over the crop until the plants are about six inches high, after which a single horse cultivator, which will go between the rows or a two-row cultivator, which will straddle the rows, should be used. The depth of cultivation should be from two to three inches Deeper cultivation is likely to injure the roots which grow within a few inches of the surface and soon extend from row to row.

Under most conditions three or four cultivations will be sufficient, though occasionally more will require to be given. A badly prepared seed bed, a heavy growth of weeds, and frequent showers will increase the number necessary for the best results.

For areas up to 10 or 15 acres the single horse hoe or cultivator, similar to that shown in the illustration, is very suitable. This is light to handle, and with practice a smart driver can become so expert as to destroy frequently weeds which may be found growing between the individual plants in the drill.

For larger areas than 15 acres a double-row cultivator of the same type, and which will straddle the rows, can be obtained.

Harvesting.—When required for grain the most common practice is to allow the crop to stand in the field until the grain is quite ripe, a condition which is indicated by the husks becoming dry and hanging down. These are then gathered by hand and husked in the field or in the barn.

Unless the grain is quite dry when gathered it should not be stored away with the husks on, as it is likely to heat and mould. Until thoroughly dry the cobs can be stored only in open sheds which admit of a free circulation of air.

After the ears are husked and the grain thoroughly dry, they require to have the grain shelled off them. This is done slowly by holding the cob in one hand and forcing the grains off with the thumb and palm of the other hand or by the core of another cob. Shelling is done more expeditiously by maize shelling machines operated by hand or power.

The maize grain is a very concentrated form of food, similar in value to wheat. On account of its hard character it is usually cracked before being fed to stock. It is extremely useful for feeding to farm horses, and has not the same injurious effects as is experienced with wheat. Large quantities are, however, somewhat heating, though in some parts of the Eastern States it is practically the only grain fed to horses which are working hard.

For the best results, as a concentrate for milking cows, it requires to be mixed with some more nitrogenous food, such as peas.

For pig raising, the twin ally of milk production, maize grain ranks very highly and is complementary to the separated skim milk left on the dairy farm, as this is rich in proteins and ash, and in consequence balances the maize, which is rich in carbohydrates.

The "core" or "cob" has a slight feeding value. Some farmers grind the whole of the ear, *i.e.*, the grain and the cob, together, and the meal thus produced is then known as "Corn and Cob" meal. It is difficult and expensive to grind the "core" to a reasonable degree of fineness, and it is somewhat doubtful whether the feeding value of the "core" is worth the cost of grinding. In this connection it is believed that the principal function of the "core" in such meal is to lighten the mixture, thus facilitating the digestion of the ground corn grain.

The unit by which maize grain is sold is the "bushel". The bushel proper is a measure of capacity, but maize is not measured but weighed, and the term "bushel," as understood in connection with maize, is a conventional one and means 56lbs., which is the approximate weight of a measured bushel of grain. To sell a bushel of maize is therefore to sell 56lbs. weight. About 75lbs. weight of "ears" will produce about 56lbs. (1 bushel) of grain.

The stalks and leaves—"stover"—which are left after the "ears" have been removed contain about one-third of the total food produced by the plant. Therefore much will be lost if this is not saved. If left in the field its food value rapidly

diminishes. Because of this the more modern practice is to cut the crop (stalks and grain), after the grain has commenced to colour and dent, and tie the bundles and stook them until the grain is dry and the stalks cured, say, five or six weeks. The cobs are removed and the fodder stored away until required.

A Non-irrigated Fodder Maize Crop, Busselton.

The "stover" is not as valuable as the maize fodder (green stalks with unhusked cobs attached) but is very useful for idle horses, and for the maintenance of dry cattle over the winter. Its value is enhanced when the stalks are run through a chaff-cutter or shredded, *i.e.*, dealt with by a machine which tears the stalks into

strips or shreds, and known as a "shredder." Machines are now available which will take the corn stalks with cobs attached and deal with the whole material, husking and shelling the cobs and shredding the leaves and stalks in one occupation.

Henry, in his "Feeds and Feeding," has pointed out that the results of experiments conducted by Ladd, at the New York (Geneva) Experiment Station, show that the nutrients in a crop of maize increase very considerably from the time of tasselling to maturity. When tasselled the crop weighed nine short tons (18,045lbs.) more than eight of which were water. The weight of the crop continued to increase until the grain reached the full milk stage, after which it decreased. Between the milk and glazing stage there was a loss of water, but a remarkable increase in quantity of nutrients, as shown by an increase of over a ton of dry matter in 17 days. From the glazing period until fully ripe there was a further slight increase in nutrients. The results show that through the various stages until the "glazed" period there is a constant and considerable increase in the nutritive value of the plant. Because of this the crop intended for fodder should not be harvested before the grain is glazed. For silage purposes it should not be delayed beyond this period, as the plants then contain the proportion of water required for good results.

The green crop can then be cut with a short scythe, cane knife, or hoe. For large areas a special machine known as a "maize harvester" is on the market. This machine cuts the stalks and binds them into bundles, just as a reaper and binder deals with the wheat crop. The advantages of such a machine when making silage are obvious.

For silage the green material is placed at once, preferably chaffed, into the "pit," "trench" or "above ground" silo, or unchaffed into a stack. It is important for those who have silos to realise that if desired the material can be used from the silo immediately after being placed therein. In this way the silo acts as a store house to enable a green crop to be harvested at its most nutritive stage, and used whilst in that condition.

The green fodder can be made into good coarse hay, and for this purpose should be tied into handy sized bundles or sheaves, and a number of them, say, five to seven, stooked together in the field until thoroughly air dried. It should then be placed under cover and chaffed before being fed to stock. The disadvantage of making it into hay is the long period necessary for curing—five to six weeks—during which time a considerable amount of food material is lost.

Valuable as the maize fodder is, it must be recognised that it is not a complete food in itself for dairy stock or working animals. Just as bread forms a very solid foundation in the dietary scale of human beings, so maize fodder, whether as silage for milch cows or hay for horses and dry cows, can play a similarly useful part in the rations of farm animals. Even well-cared-for "stover" has a greater feeding value than is generally believed, and is most suitable for idle stock during the winter. All forms of maize fodder can be utilised to supply in a cheap way the bulky and carbonaceous part of the food required by milking cows. To obtain the great benefits capable of being derived from its use with milking cows or young stock, it requires to be fed in conjunction with some legume, such as the clovers or lucerne, which should be grown on the farm to maintain, and even increase, its fertility and at the same time supply the protein and ash, the food constituents in which maize is somewhat deficient.

DOWNY MILDEW OF TOBACCO.

Two Recent Outbreaks near Perth.

SPRAYING AND OTHER NECESSARY PRECAUTIONS.

H. A. PITTMAN, B.Sc. Agr.,
Plant Pathologist.

It is desired to draw the attention of all tobacco growers in this State to two recent serious outbreaks of Downy Mildew (*Peronospora sp.*) (so-called "Blue Mould") of tobacco in seed-beds at Middle Swan and Belmont.

In view of these outbreaks and the extreme seriousness of the disease, tobacco growers in all parts of the State are warned to take no chances of having downy mildew break out on their seedlings, but to spray them as a routine precautionary measure with 4-6-50 Bordeaux mixture at weekly intervals from the time the plants reach the four-leaf stage until they are ready for planting out. After the young plants have recovered from the shock of planting out, one further spraying as above may be given, but should not be required under normal weather conditions, as downy mildew (so-called "blue mould") is essentially a seed-bed disease in this State.

There is a tendency on the part of many growers who disinfect their seed-beds before sowing, and who use disinfected seed, to consider that these two precautions are all that are required to safeguard the plants from this dread disease. Nothing could be more fallacious, as there are so many different and unsuspected ways in which the disease may be introduced on to a property that the only safe procedure is for the grower to assume that it will inevitably occur each year unless the plants in the seed-bed are periodically sprayed with Bordeaux mixture as recommended above. Not to do this is like expecting an army to successfully withstand the onslaught of its adversaries without providing it with any weapons of defence. Bordeaux mixture, properly prepared, and applied as often as is necessary to keep the young growth covered with a thin film of spray (*i.e.*, at about weekly intervals), is an effective defence against the onslaught of many downy mildew fungi; but it is powerless to cure the plants after they have once been successfully attacked.*

OTHER NECESSARY PRECAUTIONARY MEASURES.

Certain other precautionary measures must be taken in addition to those already mentioned, so as to leave no stone unturned in an effort to secure healthy seedlings for planting out. These include the keeping of the surface of the seed-bed as dry as possible, watering the seedlings only when absolutely necessary, and then in the mornings, never at night; the maximum possible exposure of the seedlings to sunlight; *early thinning of the seedlings so as to allow plenty of air and sunlight to surround each plant*, and efficient covering of the seed-beds at night to keep up the temperature and during wet weather to keep the plants dry. Further, the keeping

* Experience in many parts of the world indicates very clearly that "home-made" Bordeaux Mixture has much better fungicidal and adhesive properties than most of the so-called "Bordeaux" proprietary substitutes. In addition, the "home-made" material, if properly prepared, is much less likely to "burn" the plants. The writer recently witnessed a tobacco grower spraying his tobacco seedlings with a proprietary "Bordeaux" which was so useless that, even when applied at twice the recommended strength, no vestige of spray was to be seen on the plants several minutes after it had been applied.

down of insect pests which may introduce the disease from other properties or spread it rapidly when once it has been introduced, should be given attention. Growers should refrain from visiting one another's seed-beds and should plant out

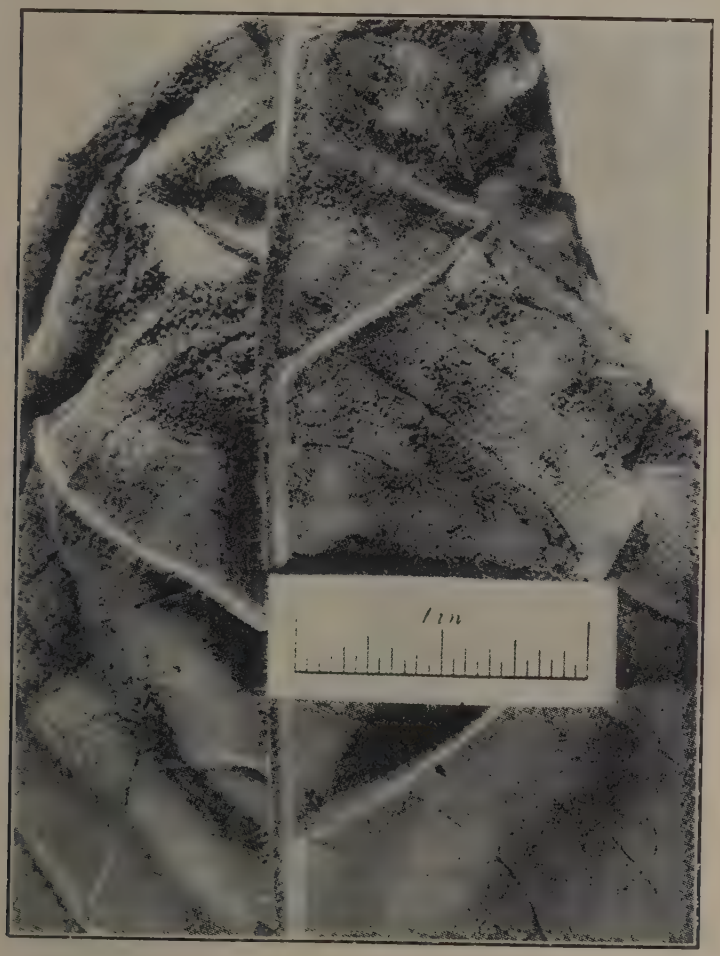


Fig. 1. Under-surface of tobacco leaf badly affected with downy mildew (*Peronospora sp.*), showing the characteristic shrivelling of the affected portions and the very copious production of white, greyish, or violet-tinted fruiting bodies (*conidiophores*) on the under-surface. The lower right portion of the leaf is still healthy.

After Mandelson, Queensland Agric. Journal, August, 1931.

their seedlings as soon as possible, as the disease is usually of very little consequence once the seedlings are planted out.

The covers to the beds should be water-tight and should have a pronounced slope so as to shed the rain outside the beds and keep the plants quite dry during wet weather.

The remains of each season's plants should be destroyed as soon as the final harvesting of leaves is over, so as to prevent the carrying over of the disease from one season to another on over-wintering plants. If this work is left until the heavy autumn rains arrive it is very difficult to successfully burn the old plants. This work should certainly be carried out at least several weeks before any new seed-beds are prepared.

Seed should not be sown too early. In both of the instances referred to in the opening paragraph of this article many of the seedlings were already planted out in the field by the middle of August. On one of the properties seed was sown on the 18th April. This is simply courting disaster. The earliest sowings should not be made before the end of June.

PREPARATION OF BORDEAUX MIXTURE IN SMALL QUANTITIES.

Spraying should not be done during the heat of the day or when the plants are drooping, but during fine dry weather, and preferably in the morning when the leaves are dry.

The directions for preparing approximately 4-6-50 Bordeaux mixture (actually 4-6-48) in small quantities are as follows:—

Take 4 ounces of bluestone and dissolve it, using hot water if desired, in 1½ gallons of water in a wooden, earthenware, copper, bronze, glass, or enamel vessel (metals other than those mentioned should not be used, as they are attacked by the bluestone). In another container of any kind slake 6 ounces of best quality, freshly burnt stone or quick lime in another 1½ gallons of water (air-slaked lime is useless for preparing Bordeaux mixture).

Then pour these two substances, after cooling, simultaneously through a piece of coarse cloth or brass strainer (to remove pieces of grit, etc.) into the spray outfit and apply to the plants immediately, using a fine mist-like spray which will thoroughly cover but not drench the foliage.

If any spray is over after each treatment, it must be discarded, as Bordeaux mixture rapidly deteriorates on standing after being prepared.

A rough but useful test which should always be carried out after the Bordeaux mixture has been prepared and before spraying the plants with it, is to dip the clean blade of a penknife or a bright piece of iron such as a roughened-up shiny nail into the mixture for several minutes. If the mixture, by any chance, does not contain enough lime, a reddish-brown deposit of copper will form on the iron, and more lime should be added until, on further testing with a fresh knife-blade or shiny nail, no stain is obtained. If this test is always carried out before spraying with Bordeaux mixture there need be no fear of burning the plants with the spray.

STOCK SOLUTIONS OF BLUESTONE AND OF LIME.

Where Bordeaux mixture has to be used at frequent intervals it is a decided advantage in many ways to make up stock solutions of bluestone and of lime as follows:—

1. Dissolve any desired quantity of bluestone (say 10 lbs.) in water in a wooden barrel, or earthenware, enamelled, glass, copper, brass or bronze vessel, at the rate of 1 lb. of bluestone to every gallon of water, by suspending the bluestone just below the surface of the water in a piece of sacking from a stick placed over-night across the container. When all the bluestone has been dissolved the solution then contains 1 lb. bluestone to the gallon of solution.

2. Into another container of any kind place a weighed-out quantity of quicklime (say 10 lbs.), then add water little by little until the slaking is completed, and finally add more water to make the final volume of the "milk of lime" equal to the same number of gallons as the number of pounds' weight of quicklime taken (*i.e.*, say 10 gallons). This mixture now contains the equivalent of 1 lb. quicklime to the gallon of "milk of lime."

PREPARATION OF BORDEAUX MIXTURE FROM THE STOCK SOLUTIONS.

To make 4-6-50 Bordeaux mixture from these stocks, *firstly*, take *1 quart* bluestone stock solution and dilute it in a wooden barrel, or earthenware, enamel, brass, copper, glass, or bronze container with water to make 1½ gallons.

Secondly, take *3 pints* lime stock solution, after stirring thoroughly to evenly distribute through the water the lime which has settled, and dilute with water in any sort of container to make 1½ gallons.

Then *thirdly*, pour these two liquids together simultaneously through a piece of cloth or brass sieve to remove grit and coarse particles, thus making 3 gallons 4-6-50 Bordeaux mixture.

Bluestone stock solution prepared as above will keep indefinitely. Lime stock solution prepared as above will keep 12 months with a loss of only ¾ lb. per cent. active lime.

When finished with each stock solution, each time, make a mark at the top of the liquid and replace any evaporated water before using again.

Use a separate vessel for dipping out the required amount of each stock solution, so as to prevent deterioration of each stock.

INCREASING THE SPREADING AND ADHESIVE QUALITIES OF THE SPRAY.

The spreading and adhesive qualities of this spray may be considerably increased by adding ¼ pint of sweet skimmed milk, or ½ to 1 oz. of flour, or 2 to 3 ozs. of good-quality soft soap, or ½ to 1 oz. of calcium caseinate spray spreader, or ½ to 1 oz. of powdered skimmed milk to every three gallons of spray immediately prior to using. In the case of the flour, soft soap, calcium caseinate or powdered skimmed milk, mix up thoroughly with a little water before adding to the spray. Then mix thoroughly through the spray. In the case of the soap it is very important only to add immediately before spraying. All the spraying utensils should be thoroughly washed out after use.

FURTHER INFORMATION.

Further information *re* the downy mildew disease of tobacco is obtainable in leaflets Nos. 329 and 329a, or pages 264-72 and 97-103 of this Journal for June, 1931, and March, 1932, respectively, and on Bordeaux mixture in Leaflet No. 314, or on pages 600-609 of this Journal for December, 1930.

CONCLUSION.

As the writer has always contended (*loc. cit.* previous paragraph) no single measure will of itself suffice for the control of such a serious disease as the downy mildew disease of tobacco. Early destruction of all remains of tobacco plants at the end of the season: eradication of wild tobacco (*Nicotiana suaveolens*) and any

other *Nicotiana* species growing in the locality; the use of healthy seed or seed disinfection: seed-bed disinfection or the use of completely new sed-beds each year; early thinning out of the seedlings so as to have only one plant to every square inch, or, even better, two square inches; the maximum possible exposure of the seedlings to sunlight; watering of the seedlings only when absolutely necessary and then only in the mornings, never at night; keeping up the temperature as much as possible at night; the use of sloping covers to the beds which will shed the rain during wet weather; routine weekly sprayings with home-made Bordeaux mixture; seasonable sowing of the seed, and the planting out of the seedlings into the field as soon as possible after the danger from frost is over; all these operations must be regarded as integral parts of the process for raising downy-mildew-free tobacco seedlings.

The raising of tobacco seedlings is not an occupation to be undertaken by the average "man in the street," or even by the average farmer. It is a job for a specialist.

My observation of many tobacco seed-beds convince me that the great majority of tobacco growers have still a great deal to learn as to the production of sturdy tobacco seedlings, quite apart from keeping them free from the ravages of downy mildew.

Wilson Patent Cooler.

This advertisement announces our **New Service Department.** If your **Wilson Patent Cooler** is beginning to look shabby now, write to—

E. WILSON, WOOROLOO,

for particulars

"How to Renovate a Wilson Patent Cooler."

The right quality hessian is supplied, cut, fitted and sewn, ready to slip on.

Aluminium paint, brush, twine, needle, and any spare part supplied.

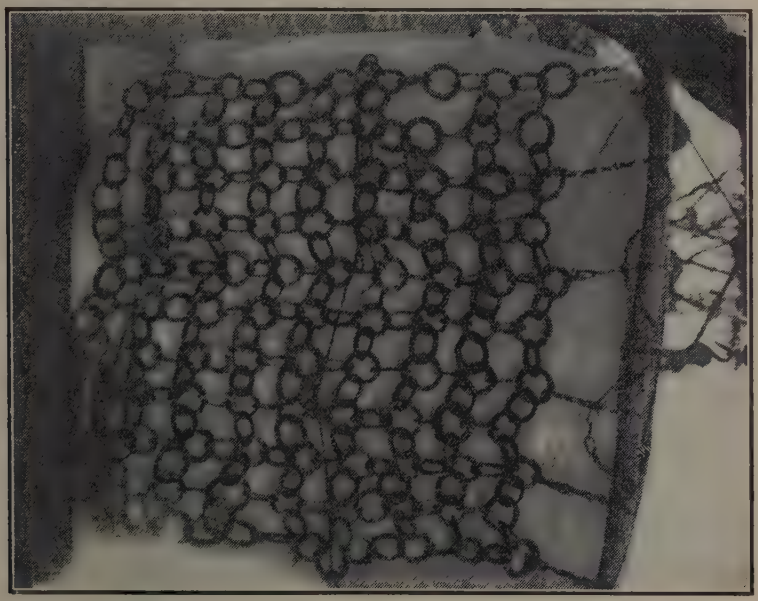
1—1

PASTURE HARROWS.

CHEAP METHOD OF MAKING CHAIN HARROWS FROM OLD HORSESHOES.

H. G. Elliott.

The use of efficient pasture harrows is desirable, and is one of the beneficial features of the new system of pasture management. If farmers carry out the regular and even distribution of the droppings, it results in more even growth as the season progresses and reduces the tendency of having tufty, unpalatable pasture produced.



Chain harrows made from old horse-shoes.

A cheap and efficeint method of making chain harrows out of old horseshoes, for spreading the droppings of animals, has been received from Messrs. Wilkinson Bros., of Millbrook, Albany. The accompanying photograph illustrates the method used for making.

Messrs. Wilkinson Bros. state that to make a set for two light horses to pull easily it requires 277 shoes; these are arranged so that there are 21 across and 17 down.

The shoes are heated and rounded so that the ends are slightly overlapping. Six lengths of plough chain are used for connecting the harrows up with the front bar. At two places, about one-third and two-thirds of the way back from the front bar, spreaders in the form of quarter-inch bars are used. These are comprised of

three short bar lengths joined together by rings. The short lengths allow for the irregularity of the ground when the harrows are in operation. The spreaders are only connected to the outside shoes.

This home-made harrow has been operated very successfully by Messrs. Wilkinson Bros., and they state that it breaks up the droppings of animals that have been out in the paddock throughout the summer months.

CHEAP SILAGE CONSERVATION.

G. K. BARON-HAY,
Superintendent of Dairying.

The climate of the greater part of the South-West agricultural area of this State, resulting in a more or less protracted dry summer, makes it imperative for all farmers to consider means whereby fodder can be conserved for hand feeding during those months of scarcity. For dairy cattle it is imperative that this fodder should be of a succulent nature, so as to replace green herbage as far as possible. The only certain method of carrying this out is by the preservation of winter crops in their green state in the form of silage.

Although overhead tub silos are recommended where they can be cheaply constructed, the writer does not believe this expense justified on a dairy farm in the initial stages of development.

In certain districts where timber is cheap, "face-cut" silos may be economically erected, as described in an article by Mr. M. Cullity in September issue of "Journal of Agriculture," 1930. These silos are common in the Manjimup-Jardee area, which are near to the timber mills with cheap seconds and reject timber available. The following particulars are given by Mr. Cullity.

This silo as erected is square, having usually 8 to 10 feet sides. The construction is very simple, and may be seen in a glance at the accompanying photographs. Four corner posts are erected, round bush poles being just as suitable as sawn timber. Cross bearers are inserted on the inside of the posts in a horizontal position. The face-cuts are then fastened vertically to the inside of these, and arranged so as to have as smooth a surface as possible inside.

The cost of the silo is very small; an idea of it may be obtained from the following figures given by Mr. W. Kjellgren, of Middlesex, Jardee. His silo is 8 feet square and in all is 17 feet in height, but, as it has been erected in an old pit 6 feet deep, it stands only 11 feet above ground. The materials for this were as follows, Mr. Kjellgren making no allowance for his own labour, being concerned only with the actual amount of cash having to be paid out:—

	£	s.	d.
32 face-cuts 17ft. x 1ft. x 1in., at 1s. each	1	12	0
9 feet 4in. x 2in.	0	12	0
Nails, 4 to each board on each batten	0	6	0
	£2	10	0

Labour charges were not made, as Mr. Kjellgren contended that the whole was erected during slack periods, and periods of broken time when no other useful work could have been attempted.

Another farmer using this same type of silo is Mr. W. Cox, of Jardee. In this case the dimensions were 9ft. x 9ft. x 18ft., the bottom of the silo being 4 feet below ground level. The face-cuts used were wider than those obtained by Mr. Kjellgren, being up to 18 inches in width, and the consequence is that more warping has taken place. Mr. Cox intends to either replace these warped boards with narrower ones, or split them, giving a better hold on to the bearers, minimising the tendency to warp.

The cost of this silo without labour charges was £4, including bearers, face-cuts, nails, and cartage from the Jardee mill, approximately six miles.

An illustration of this silo is shown below.

Illustration I.—Facecut Silo erected by Mr. W. Cox, Jardee.

Mr. G. F. Combs, of Jardee, is another who has been particularly successful in using this type of silo. This silo was estimated by Mr. Combs to have cost £7, including the charge for labour used in its construction. This one differs from those previously described in that it is wholly above ground and that, in general, narrower boards have been used, mainly flooring board size.

In 1928-9 season a comparison was made by the writer of the measured loss in these silos as against the measured loss in open stacks. There were some very bad attempts at making silage by both methods, but the worst failure with the face-cut silo could not be compared with the loss made in several stacks.

Much of the loss was caused by lack of knowledge of the process of ensilage, crops being cut too late, left too long before carting in, and bad stacking and trampling being responsible in many cases for building up the waste beyond a reasonable figure.

The summary of the comparison above referred to showed that the average loss in the face-cuts was one-half only of the loss in the stacks. One or two stacks inspected were complete failures, while the worst face-cut was better than the best stack. I am referring here still to the amount of loss, not wishing to make any comparison between the quality of the silage made by the two processes.

The disadvantages most frequently quoted against this system is that of difficulties in filling and emptying. This seems really great, but only then when compared with the stack, and even then the disability appears greater than is actually the case. In the stack the material is forked direct from the cart or sledge on to the top of the stack, while, in the other type, the filling takes place either over the top of the structure or else through the doors which are left in the better type. A whip-stick arrangement is used by Mr. Grumpelt for filling, while Mr. Crawley has a special loading fork and derrick. The unloading problem where doors are left at convenient heights is no different from that of a stack.

A few points that assist in reducing waste by this method are enumerated below:—

1. When wide face-cuts are used, they should be secured to the battens their whole width, otherwise warping will occur which will allow more air to reach the curing silage. Where green boards only can be obtained, it is much preferable to use narrow boards, as the tendency to warp is minimised.

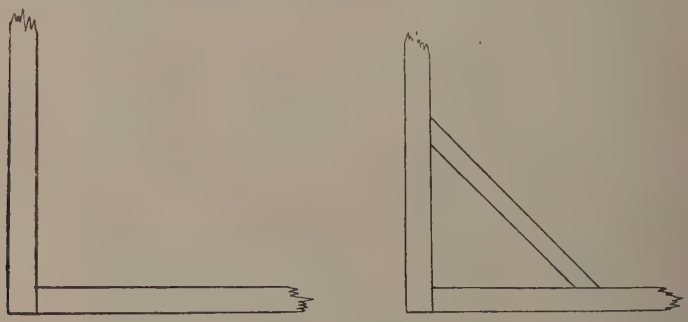


Illustration II.

2. The vertical boards should be as close together as possible so as to exclude air.

3. Where possible it is advisable to have the bottom of the structure below ground, as air is completely excluded in this portion. Four or five feet below ground level is not inconvenient.

4. Some of the waste in the square corners may be eliminated by placing in the angle about the position of the cross bearers a small batten, to which face-cuts may be nailed on the inside, so doing away with the right-angle corner as shown.

The following applies to stack, pit, and other methods of ensiling:—

5. The crop should be cut early. Where ordinary pastures are concerned, cutting may take place late in September or early in October. Less waste will

result from silage made at this season than would be the case with later cutting. Cutting earlier than this would result in a too sappy or mushy silage with a considerable loss in feeding value.

The farmer in any case must arrange his work so that his ensilage season is finished before his paddocks are ready to cut for hay. Once the time for hay-cutting arrives, the farmer's energies are more profitably devoted to making hay.

6. Only as much material should be cut in one day as can be carted in and placed in the silo on that day. The usual method on most small farms is to cut in the morning and cart in during the afternoon.

7. The material first cut should be first carted.

8. In loading the silo, the material should be spread evenly and well trampled, paying most attention to the sides and corners. When leaving at night have some handy weights close by for laying on top. A few planks and sand-bags serve the purpose; when full, cease cutting for a while till subsidence takes place. A convenient method of deciding when the recommence loading is to wait till the heat generated in the material can be felt in the top layer. This applies more particularly to where the material can be carted in fast. This filling and waiting to sink has to be continued for some time. Of course, the more carefully this is done, the more material ensiled and the better the resulting material will be.

Commencing to fill a "trench" or "clamp" silo on property of Mr. Davis, Gnowangerup.

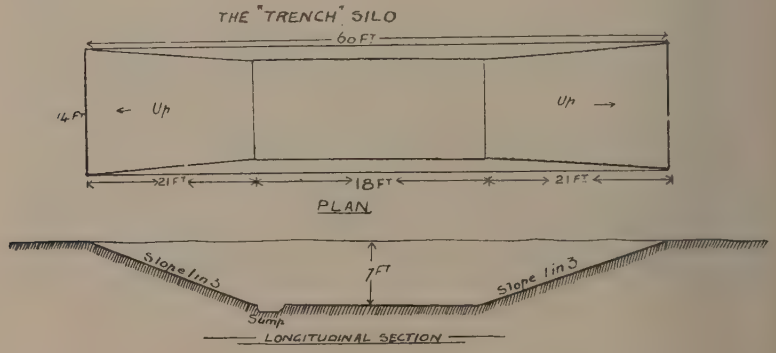
In areas of lighter rainfall or very dry conditions during summer months the pit or trench method of conserving silage is to be recommended. Success in the case of the stock is dependent on a considerable proportion of the green material being clover. This is not possible in the drier areas, where the crop to be ensiled is usually a cereal.

The following notes regarding the making of silage by the trench method may be useful.

Choosing the Site for "Trench."—The site chosen should be elevated and well-drained, and as near the feeding troughs as practicable. A clay soil is preferable to a loamy one, but sandy soils should be avoided. In a sandy soil the seepage of water into the trench from the surrounding country would be considerable, any may act detrimentally on the silage. Should the drainage of the site not be good, a drain two feet deep should be dug round the trench after its completion, which will carry away surface water, and also the water which will flow from off the trench top itself, as when full of silage and covered with earth, the finished trench has the appearance of a mound.

Excavating the Trench.—Having chosen the site, the surface dimensions of the trench should be marked out by four corner pegs. The dimensions of the bottom of the trench should also be marked out, so that the slope at each end may be properly estimated. The area pegged out is now ploughed with a suitable plough, the single-furrow mould board being usually found the most convenient. The earth as it is ploughed may be scooped out with the ordinary dam-sinking scoop. The excavated earth should be placed on the sides of the trench, as it is necessary to leave the ends open for convenience in filling. A slope of one in three should be left at either end so that the horses can get in and out when excavating and so that in filling, the carts can be driven through the trench, which will assist in packing the material ensiled.

The sides of the trench should be kept as near vertical as possible, even if a little spade work is necessary. Having the sides vertical will minimise wastage, as the material can settle uniformly. When scooping out the trench it is advisable to scoop a little hollow at the end which it is intended to open first. This is to enable any drainage water that may get into the silo after it is opened, to collect in this hollow, and so not penetrate into the silage. (See diagram.)



From page 349, Vol. 1, September, 1924.

Size of the Trench.—It is not advisable to make a smaller trench than one to hold fifty tons of silage. A convenient size is one to hold eighty tons, and such a trench would require twenty acres of an oat and pea crop to supply the necessary material, taking an average yield of hay as one ton per acre.

The following table will give the dimensions of trenches to hold 80, 72, 64, and 56 tons of silage:—

	80 tons. feet.	72 tons. feet.	64 tons. feet.	56 tons. feet.
Surface length	60	60	60	60
Breadth	20	18	16	14
Depth at centre of trench	7	7	7	7

In each case a slope of 1 in 3 is allowed at either end.

Crops to Grow.—Maize, in districts where it can be grown, is undoubtedly the most economical crop to grow for silage, because of the large yields obtained Crops of maize not infrequently yield as high as 25 tons per acre of green material When maize is grown for silage it should be cut when the cob is well formed and the grain is in the doughy stage. It will be found that at this stage the lower leaves are turning brown. Where maize can be grown, however, it is often possible to grow permanent pasture, and silage in such districts is to be looked upon as a wise insurance against a failure of this pasture, and of summer crops. In the greater portion of the State, where silage is most necessary, it is not practicable to grow maize, and resource must be had to the winter-grown cereal crops.

Cereal crops should be cut a little earlier than is usually done for hay, that is, when the grain is in the milk stage, and the straw just starting to change colour at its base.

In some portions of the State the spring growth of natural grasses and wild oats is considerable, and such material can be made into silage, and is best cut when the majority of the plants are in flower. If the grasses have harsh and fibrous stems at this stage, they should be cut before flowering, if necessary.

Filling the Trench.—The material to be put into the trench is usually cut with a binder, though a mower may be used. If the binder is used, and the material tied in sheaves, it is necessary to cut the bands before putting the material in the silo. This enables the material to be more firmly packed, and also facilitates the emptying of the silo. The twine, in itself, is undesirable, as unless well softened by the fermentation of the silage, may possibly cause an obstruction in the alimentary canals of animals fed on the silage. When filling, the carts may be driven into the trench before emptying; the trampling of the horses and the weight of the cart will assist to pack the material, an important point, as the making of good silage depends on the thorough exclusion of air, which can only be obtained by firm packing.

When cutting the crop it is advisable to cut only as much crop as will be loaded into the silo that day, as remaining some hours in the open will cause a lot of the moisture to be lost from the material.

The trench should be filled until about three feet above the level of the surrounding ground, making the centre slope off towards the sides of the trench. It may be necessary to top up the trench several times, as the sinkage is considerable, and may allow the surface of the filled trench to be below ground level, which is undesirable. When the filling of the trench is completed, earth is scooped back on the material, until a layer of earth of about 18 inches thick covers the whole area of the trench. If thought desirable, the material may be covered with chaff bags before scooping on the earth, though it is doubtful if the little material saved is worth the sacks used to save it. The green material, under the considerable pressure of the earth, will sink some 18 inches to two feet, and in the process of sinking cracks may appear in the covering of earth. If any such cracks do appear they should be filled in immediately or wastage may occur at these points, due to

the admission of air. With a trench such as has been described there will be very little waste, and if not required, the silage will keep almost indefinitely.

On farms, however, where it is considered desirable to conserve fodder as silage, and neither of the above methods is applicable, then resort must be had to the stack.

Method.—The building of stack silos should only be contemplated in order to preserve fodder, which would otherwise be difficult to handle economically.

The early top-dressing of pastures is now almost universally practised throughout the Dairy Belt, and has resulted in a plethora of green fodder in the months of September, October, and November. It is probable that this flush season will be considerably increased through the judicious use of nitrogenous fertilisers for top-dressing, and experiments will be carried out in this connection during the coming season.

Once the growth of a pasture has become rank, then the feeding value is decreasing, and the fodder should be immediately consumed by stock, or treated in some other way, so that a fresh, young and more nutritious growth may take place.

Should the weather permit, which generally will not be the case before late in spring, meadow hay is recommended as the most economical method of conserving this nutritious fodder, as with well-made hay there is little if any loss in nutriment.

It already has been found necessary in certain districts, however, to cut this rank growth early in spring, while rainy conditions still prevail, and it is in such cases that the stack silo is recommended as a method of saving a large proportion of this fodder when in its most nutritious state. This silage, too, is a further provision for ensuring a supply of green material for food in the summer months.

The following points are necessary to ensure success with the stack silo:—

1. The material to be ensiled should be quite green and succulent. A number of silos were noted in which the proportion of waste was over 30 per cent., due to the material being too dry. This admits an excessive amount of air, causing moulds to develop and allows too much fermentation. Such material should be made into meadow hay.

2. A considerable percentage of clovers is desirable, the best quality silage being noted in those stacks where the material was almost entirely subterranean clover. Crops such as oats, wheat, maize, and sorghums are not recommended for stack silage, owing to the difficulty of pressing sufficiently to exclude air.

3. The stack should be square, and should contain not less than 20 tons of silage. The square stack has less area exposed in proportion to volume than the oblong one. The minimum base for a stack should be 12 feet by 12 feet.

The following table shows the dimensions of the base of stacks of varying capacities:—

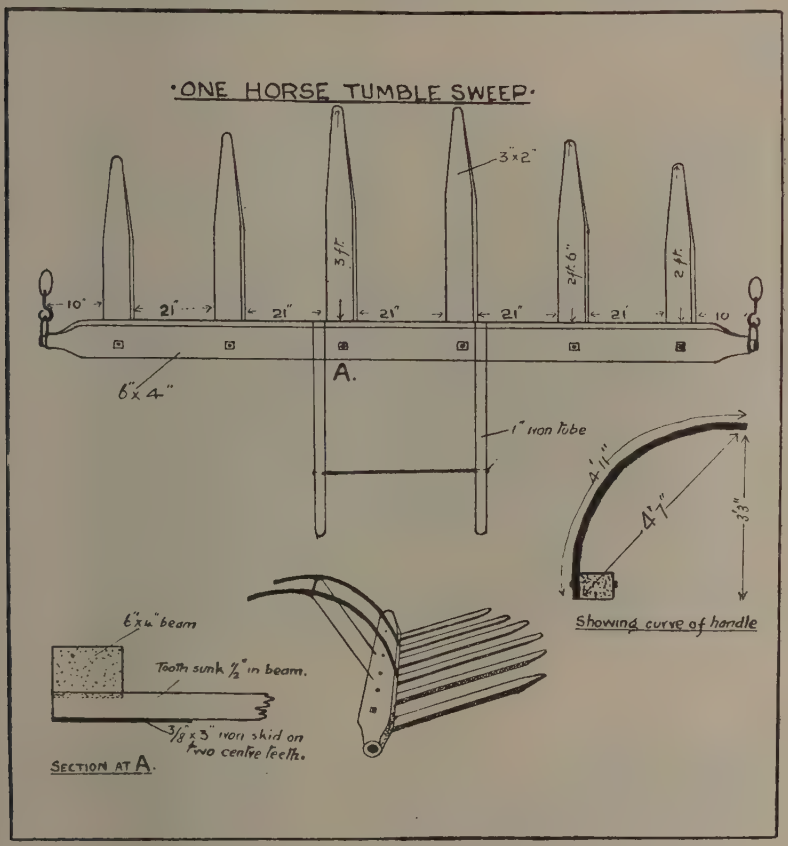
	Round Diameter Feet.
20 tons	12
30 tons	14
40 tons	16
50 tons	18

4. Grass should be cut for silage before seed-heads form, as the percentage of fibre increases very rapidly with maturity, leading to waste during fermentation owing to access of air.

5. Clover should be cut while forming seed, and before wilting commences.

6. Almost the only expense in the making of stack silage is that of handling the crop, which, without labour-saving devices, may be unnecessarily high.

The heavy work of loading green material on to drays or wagons may be considerably lightened by the use of the "Tumble Sweep," illustrated below:—



Plan of details of One-horse Tumble Sweep.

7. The stack may be completed immediately, but it will usually be found preferable to spread the building over several days. This is no detriment and allows a certain amount of sinking to take place. It should be made as high as possible, 12 feet being a convenient height before settling takes place. Care must be used to ensure the stack is on a level base and that building has been even, so as to allow for regular sinking, otherwise the stack will slip, open, and the material be ruined.

Cutting, carting and stacking may be continued irrespective of the weather, whether rainy or fine. In order to prevent slipping, posts may be placed at each corner, more than four being undesirable, as likely to prevent even settlement.

8. As each day's portion of the stack is built, the sides should be scraped free from loose material, which otherwise would be wasted.

9. The stack should be finished off flat at the top, so that posts or planks may be placed thereon, and sacks of dirt or loose earth thrown on to assist in excluding the air by pressure—9 inches of earth has been found quite sufficient, or a layer of sugar-bags of earth placed on posts.

Subsidence is considerable, a 12ft. stack commonly sinking to 5 or 6 feet within six weeks.

10. An examination of a number of stacks has shown that, where the average depth to which air has intruded on three sides may be not more than 8 inches, on the side of the prevailing winds during the hot months the material has been destroyed to a depth of 18 inches, through infiltration of air and the drying effect of

One-horse Tumble Sweep being operated on farm of Messrs. Bayley Bros., Denmark.

Showing tumbling action of sweep, minimising handling the material.

the wind. It is recommended that this side be protected either by sheet iron or by bushes built against the stack, so as to break the force of the wind.

11. Stacks should be opened from the top, a full layer not less than 1½ inches thick being removed each day. Opening from the sides exposes a fresh surface unduly, causing waste.

Feeding Silage. H. C. Barnsby, Clovelly Farm, Pemberton.

12. Good clover silage does not need the addition of a concentrate when fed to cows of average production. When silage is made from grass or cereal crops, however, disappointing results are obtained where fed alone to milk cows, ewes, or lambs. The addition of a concentrate such as oats, bran, linseed meal, peas, etc., is then necessary to increase the protein content, otherwise supplied by the leguminous crop.

A well-built 40-ton silage stack. Dr. A. G. Abbott, Eastbrook. Bags of earth held in position by wire threaded through end; centre filled with earth.

THE COST OF FEEDING PURE-BRED COWS UNDER THE AUSTRALIAN OFFICIAL HERD-RECORDING SCHEME, WESTERN AUSTRALIA, 1931-32.

G. K. BARON-HAY, Superintendent of Dairying,
L. C. SNOOK and H. G. ELLIOTT.

Since 1924 an accurate record has been available regarding the costs of feeding the pure-bred cows under official test. Monthly visits to the herds under test are made by the recording official, who records the rations being fed, together with the butter fat and milk record of cows in the various herds.

The following tables give the cost of feeding, together with other information relating to production, of the herds under test during 1931-32.

The various foodstuffs were valued at the average rate ruling during the twelve months ended 30th June, 1932, as follows:—

	£ s. d.	
Chaff—Oaten or Wheaten	4 0 0	per ton.
Loose Hay	2 0 0	„
Clover Hay	2 15 0	„
Silage	0 7 0	„
Oats (Crushed)	0 2 0	per bushel.
Wheat	0 3 4	„
Bran	5 10 0	per ton.
Pollard	5 17 6	„
Linseed Meal	12 10 0	„
Lucerne Hay	6 0 0	„
Green Lucerne	1 10 0	„
Oil Cake	0 12 0	per cwt.
Meat Meal	0 7 9	per 50 lbs.
Grains	0 0 6	for 75 lbs.
Potatoes	2 15 0	per ton.
Maize ... } Grazed	0 2 6	per head,
Sudan Grass }		per week.
Barley ... } Chaffed	0 6 0	Per ton.
Pasture	0 1 6	per head per week.

The results obtained during the period under review show that the low costs arrived at during the previous year, 1930-31, have been maintained by breeders. This is no doubt partly due to the increased provision of home-grown fodders, the percentage of farmers providing silage being 62 per cent. this year, as against 37 per cent. last year (1930-31).

TABLE I.

COST OF FEED PER GALLON OF MILK AND PER LB. OF BUTTER FAT.

Year.	Average Cost of Feed per Cow for 9 months.	Cost of Feed to produce 1 gallon Milk.	Cost of Feed to produce 1 lb. Fat.
Average—	£ s. d.	d.	d.
1924–30	14 3 8	5·54	11·42
1929–30	14 10 3	5·10	12·74
1930–31	9 14 7	3·63	7·74
1931–32	10 18 3	3·76	8·21

During the period under review the price of butter-fat has fallen slightly, the average price for 1930-31 being 1s. 3d. per lb.; while for 1931-32 the average price has been 1s. 2.37d. per lb.

It is only by reducing the costs of feeding that the low prices received for butter-fat can be combated, as breeding higher-producing stock needs several years to achieve success. The increase in the number of herds being fed silage is remarkable, and is further evidence, if any be required, of the value of this fodder for the economical production of milk and butter-fat.

Table 2.

VALUE OF HOME-GROWN FODDERS.

	A. With Silage (10 herds).	B. Without Silage (6 herds).	Per cent. in favour of herds having Silage.
			%
Per llb. Butter Fat ...	7·87	9·62	22·23
Per 1 gallon of Milk ...	3·82	4·18	9·9

One of the outstanding features of the results during 1931-32 has been the excellent performances put up by cows in herds in the drier areas of the State; but on averaging the costs of feeding in these areas, the cost is high in comparison with herds in the dairy districts proper, as is shown in the following Table 3.

Table 3.

COST OF PRODUCTION IN LIGHT RAINFALL AREAS COMPARED WITH SOUTH-WEST CONDITIONS.

	Production.		Cost of Feed for—	
	Milk.	Fat.	1 gallon Milk.	llb. Butter Fat.
	gals.	lbs.		
9 Herds—Dry Areas ...	723·8	324·54	4·21	8·97
7 Herds—South-West ...	595·7	278·55	3·80	7·33

As in previous years, the three breeds under test have been compared as regards cost of feeding and average yields (see Table 4).

Table 4.

—	Breed.	Average Yield of Butter Fat.	Average Yield of Milk.	Average Cost of Feed.
		lbs.	gals.	£ s. d.
1	Australian Illawarra Shorthorn (6 herds)	333·00	822·55	11 15 0
2	Guernsey (3 herds) ...	314·49	606·7	11 13 3
3	Jersey (7 herds) ...	286·61	545·8	11 0 4

These figures represent the relative position of cows of these breeds for one year only, and should not be used as an argument against or in favour of any one breed.

The following is a list of the tables inserted, with the information embodied:—

Table 5. Herds in order of merit as producers of butter-fat.

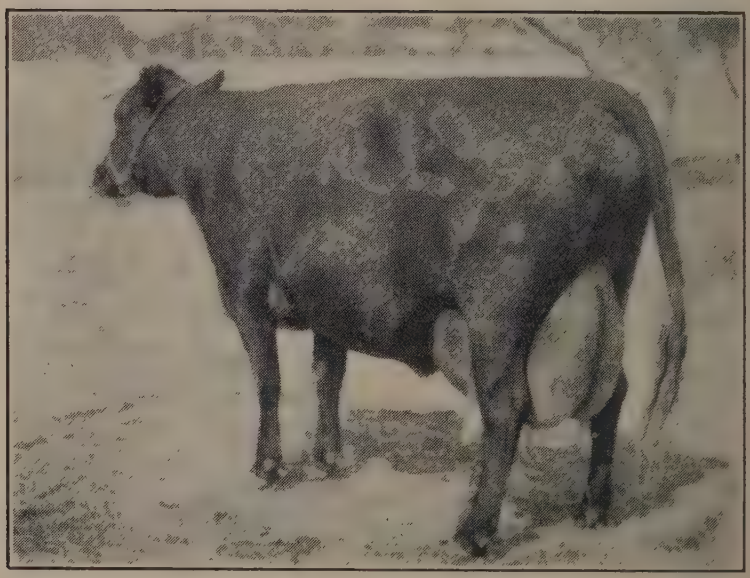
Table 6. Herds in order of merit as producers of milk.

Table 7. Herds in order of merit of cost of producing 1 lb. butter-fat.

Table 8. Herds in order of merit of cost of producing 1 gallon of milk.

Table 9. Herd averages for 9-year period.

Table 10. Summary of results, 1931-32.



Gold of East View (10940), owned by W. G. Burges, "Tipperary," York.
Top cow in Sen. 4yr.-old class. Standard 330 lbs. Butter Fat.
Production:—12,675 lbs. Milk; Av. Test 4.01%; 508.73 lbs. Fat.

TABLE 5.—HERDS IN ORDER OF MERIT AS PRODUCERS OF BUTTER FAT.

Herd.	Breed.	Average Production of Butter Fat per Cow for 9 months.	Average Production of Skim Milk per Cow for 9 months.	Value of Butter Fat at 1s. 2d. per lb.	Value of Skim Milk at 1d. per gallon.	Gross Returns for Fat and Skim Milk.	Cost of Feed per Cow for 9 months.	Profit per Cow by Sale of Butter Fat.	Cost of Feed to produce 100lbs. of Butter Fat.	Cost of Feed to produce 1 lb. of Butter Fat.
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.
A ...	Guernsey	386·91	647·4	22 11 5	2 13 11	25 5 4	14 4 3	11 1 1	3 13 6	8·82
B ..	Australian Illawarra Shorthorn	377·01	812·3	21 19 10	3 7 8	25 7 6	9 4 8	16 2 10	2 9 0	5·88
C ..	do. do. do.	352·93	809·2	20 11 9	3 7 5	23 19 2	12 19 6	10 19 8	3 14 11	8·99
D ...	Jersey	337·95	527·4	19 14 3	2 3 11	21 18 2	12 17 4	9 0 10	3 13 4	9·13
E ..	Australian Illawarra Shorthorn	335·52	767·0	19 11 5	3 3 11	22 15 4	12 12 7	10 2 9	3 15 3	9·03
F ...	Jersey	331·29	599·1	19 6 6	2 9 11	22 6 5	7 17 8	14 8 9	2 7 7	5·71
G ...	Australian Illawarra Shorthorn	314·80	696·6	18 7 3	2 18 0	21 5 3	11 9 8	9 15 7	3 12 11	8·75
H ...	do. do. do.	312·39	737·5	18 4 5	3 1 5	21 5 10	8 15 8	12 10 2	2 16 2	6·74
I ...	do. do. do.	305·37	619·2	17 16 3	2 11 7	20 7 10	15 8 0	4 19 10	5 0 10	12·10
J ...	Jersey	303·31	550·8	17 13 10	2 5 11	19 19 9	10 11 5	9 8 4	3 9 8	8·36
K ...	do.	303·12	494·7	17 13 7	2 1 2	19 14 9	13 7 5	6 7 4	4 8 2	10·58
L ...	Guernsey	286·65	504·6	16 14 9	2 2 0	18 16 9	12 17 9	5 19 0	4 9 10	10·78
M ...	Jersey	286·56	520·4	16 14 4	2 3 4	18 17 8	12 13 9	6 3 11	4 4 6	10·68
N ...	Guernsey	269·91	485·2	15 14 8	2 0 5	17 15 1	7 17 9	9 17 4	2 18 5	7·01
O ...	Jersey	224·82	422·4	13 2 3	1 15 2	14 17 5	9 7 2	5 10 3	4 3 3	9·99
P ...	do.	220·23	323·7	12 16 11	1 7 0	14 3 11	10 18 0	3 5 11	4 19 0	11·88
	Average	318·96	626·6	19 2 1	2 12 2	21 14 3	10 18 3	10 16 0	3 8 5	8·21

East View Lucky Pretty Maid 3rd (8481) owned by A. E. Grant, "Yanget," Geraldton.

Top production cow in Official Herd-Testing Scheme, 1931-32.

Production:—13,921 lbs. Milk; Av. Test 4·0%; 557·63 lbs. Butter Fat in 273 days.

Table 6.

HERDS IN ORDER OF MERIT AS PRODUCERS OF MILK.

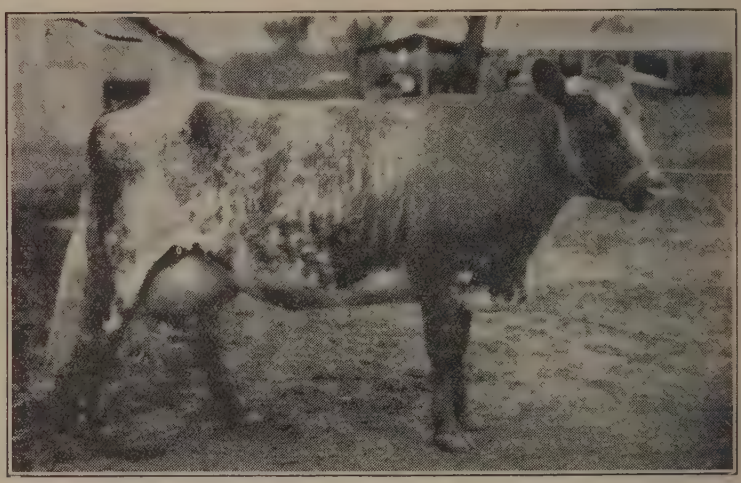
Herd.	Average Yield of Milk per Cow for 9 months.	Value of Milk at 10d. per gallon.	Cost of Feed per Cow for 9 months.	Profit on Sale of Whole Milk.	Cost of feed to produce 1 gallon of Milk.	Breed.
	gals.	£ s. d.	£ s. d.	£ s. d.	d.	
B ...	902·5	37 12 1	9 4 8	28 7 5	2·45	Australian Illawarra Shorthorn.
C ...	899·1	37 9 3	12 19 6	24 9 9	3·46	do. do.
E ...	852·2	35 10 2	12 12 7	22 17 7	3·55	do. do.
H ...	819·5	34 2 11	8 15 8	25 7 3	2·57	do. do.
G ...	774·0	32 5 0	11 9 8	20 15 4	3·56	do. do.
A ...	719·4	29 19 6	14 4 3	15 15 3	3·07	Guernsey.
I ...	688·0	28 13 4	15 8 0	13 5 4	5·73	Australian Illawarra Shorthorn.
F ...	665·6	27 14 8	7 17 8	19 17 0	2·84	Jersey.
J ...	612·0	26 0 0	10 11 5	15 5 4	5·37	do.
D ...	586·0	24 8 4	12 17 4	11 11 0	5·27	do.
M ...	578·3	24 1 11	12 13 9	11 8 2	5·27	do.
L ...	560·7	23 7 3	12 17 9	10 9 6	5·52	Guernsey.
K ...	549·7	22 18 1	13 7 5	9 10 8	5·83	Jersey.
N ...	539·1	22 9 3	7 17 9	14 11 6	3·07	Guernsey.
O ...	469·4	19 11 2	9 7 2	10 4 0	4·78	Jersey.
P ...	359·7	14 19 9	10 18 0	4 1 9	7·27	do.
Average	696·2	29 0 2	10 18 3	18 1 11	3·76	

Table 7.

HERDS IN ORDER OF MERIT SHOWING COST OF FEED PER LB. OF BUTTER FAT PRODUCED.

Herd.	Cost of Feed per lb. of Fat.	Under Average.	Over Average.	Breed.
	d.	d.	d.	
F	5·71	2·5	...	Jersey.
B	5·88	2·33	...	Australian Illawarra Shorthorn.
H	6·74	1·47	...	do. do.
N	7·01	1·20	...	Guernsey.
J	8·36	...	0·15	Jersey.
G	8·75	...	0·54	Australian Illawarra Shorthorn.
A	8·82	...	0·61	
C	8·99	...	0·78	
E	9·03	...	0·82	do. do.
D	9·13	...	0·92	do. do.
O	9·99	...	1·78	Jersey.
K	10·58	...	2·37	do.
M	10·62	...	2·41	do.
L	10·78	...	2·57	Guernsey.
P	11·88	...	3·67	Jersey.
I	12·10	...	3·89	Australian Illawarra Shorthorn.
Average ...	8·21	...	...	

Kitty 8th of Kurrawong, owned by W. G. Burges, "Tipperary," York.
Top cow in the Jun. 4yr.-old class. Standard 310 lbs. Butter Fat.
Production:—9,114 lbs. Milk; Av. Test 4.7%; 423.00 lbs. Fat.



Victress of Toora, owned by W. G. Burges, "Tipperary," York.
Highest producing cow in Jun. 3yr.-old class. Standard 270 lbs. Fat.
Production:—9,642 lbs. Milk; Av. Test 4.65%; 448.19 lbs. Butter Fat.

TABLE 8.

HERDS IN ORDER OF MERIT, SHOWING COST OF FEED TO PRODUCE ONE GALLON OF MILK.

Herd.	Cost of Food to produce 1 gallon Milk.	Below Average Cost.	Over Average Cost.	Breed.
	d.	d.	d.	
B	2·45	1·31	...	Australian Illawarra Shorthorn.
H	2·57	1·19	...	do. do.
F	2·84	0·92	...	Jersey
A	3·07	0·69	...	Guernsey.
C	3·46	0·30	...	Australian Illawarra Shorthorn.
N	3·53	0·23	...	Guernsey.
E	3·55	0·21	...	Australian Illawarra Shorthorn.
G	3·56	0·20	...	do. do.
J	4·11	...	0·35	Jersey.
O	4·78	...	1·02	do.
D	5·27	...	1·51	do.
M	5·27	...	1·51	do.
I	5·37	...	1·61	Australian Illawarra Shorthorn.
L	5·51	...	1·75	Guernsey.
K	5·83	...	2·07	Jersey.
P	7·27	...	3·51	do.
Average ...	3·76	...	...	

TABLE 9.

HERD AVERAGES FOR 9 YEARS—1924-1932.

Year.	Milk.	Average Fat per Cow for period of 9 months.	Average Skim Milk per Cow for period.	Value of Fat for period.	Value of Skim Milk for period at 2d. per gallon.	Average Value of Fats and Skim Milk for period.	Cost of Feed per Cow for period.	Net profit per Cow for period through sale of Fat.	Value of Whole Milk at 1s. 3d. per gallon allowing for rearing calf.	Net profit per Cow through sale of Fresh Milk at 1s. 3d. per gallon.	Average Cost to produce 1 lb. Fat.	Average Cost to produce 1 gallon of Milk.
	gals.	lbs.	gals.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		
1924 ...	600	319·50	362	At 1s. 7d. per lb. 25 19 2	3 0 4	28 19 6	10 4 10	18 4 8	32 1 3	21 16 5	7·70	4·09
1925 ...	652	303·53	407	At 1s. 5½d. per lb. 22 10 0	3 7 10	25 17 10	14 13 2	11 4 8	30 10 5	15 9 5	10·77	6·15
1926 ...	624	312·01	393	At 1s. 7d. per lb. 24 14 0	3 5 6	27 19 6	14 14 7	13 4 11	32 5 5	17 10 10	11·15	5·66
1927 ...	602	290·72	382	At 1s. 7d. per lb. 23 0 4	3 0 4	26 0 8	14 10 5	12 6 8	31 10 6	17 0 1	12·00	5·76
1928 ...	592	280·56	353	At 1s. 7½d. per lb. 22 15 9	2 18 10	25 14 7	15 11 4	10 3 3	30 19 0	15 7 8	13·34	6·34
1929 ...	629	295·10	386	At 1s. 8d. per lb. 24 11 10	3 4 4	27 16 2	15 1 0	12 15 2	33 6 9	18 5 9	12·24	5·74
1930 ...	636	294·98	369	At 1s. 7½d. per lb. 23 19 6	3 5 4	27 4 10	14 10 3	12 14 7	30 3 3	15 13 0	12·74	5·10
1931 ...	643	301·69	399	At 1s. 4d. per lb. 20 2 2	At 1d. per gal. 1 13 3	21 15 5	9 14 7	12 0 10	At 1s. 1d. per gal. 25 10 1	At 1s. 1d. per gal. 15 15 6	7·74	3·63
1932 ...	636	318·96	479	At 1s. 2d. per lb. 19 2 1	At 1d. per gal. 1 19 11	21 2 0	10 18 3	10 3 9	At 10d. per gal. 25 0 0	At 10d. per gal. 14 1 9	8·21	3·76
Average, 9 years	630·5	302·42	378·8	23 1 8	2 17 3½	25 18 11½	13 6 6	12 12 5½	30 2 11	16 16 5	10·57	5·07

TABLE 10.

SUMMARY OF RESULTS, 1931-32.

PRODUCTION PER COW FOR 9 MONTHS.

1.—696 gallons of Milk per Cow.
2.—318·9 lbs. of Butter Fat per Cow.

	£	s.	d.
1.—Value of Butter Fat at 1s. 2d. per lb.	19	2	1
Value of Skim Milk at 1d. per gallon	1	19	11
Total return by sale of Butter Fat	21	2	0
Cost of Feed for Period	10	18	3
Gross Profit	10	3	9
2.—Value of Whole Milk at 10d. per gallon	25	0	0
Cost of Feed for Period	10	18	3
Gross Profit	14	1	9
Cost of Feed to produce 1 gallon of Milk		3·76d.	
Cost of Feed to produce 1lb. of Butter Fat		8·21d.	

Nooka Wild Rose (28191), owned and bred by S. P. Herbert, "Nooka," Nungarin.

Top cow in Sen. 2yr.-old class. Standard 250 lbs. Butter Fat.
Production:—6,619 lbs. Milk; Av. Test 5.43%; 358.55 lbs. Fat.

"THE JOURNAL OF AGRICULTURE"

will be supplied free *on application* to any person in the State who is following Agricultural, Horticultural, or Viticultural pursuits, to Agricultural Societies or Associations, and to any person otherwise interested in Agriculture.

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The current list of recipients will be revised after the December issue this year, and all who desire continuance, or renewal, are requested to notify the Director of Agriculture, otherwise their names will be removed therefrom.

Esperance Wheat Lands.

LIVE STOCK AND MEAT.

For the information of readers of this "Journal," the following particulars have been supplied by Messrs. Elder, Smith, and Coy., Ltd., Perth:—

COMPARATIVE NUMBERS OF STOCK SOLD AT METROPOLITAN FAT STOCK MARKETS, FOR MONTHS OF JUNE, JULY, AND AUGUST, 1932.

—	JUNE.					JULY.				AUGUST.				
	1.	8.	15.	22.	29.	6.	13.	20.	27.	3.	10.	17.	24.	31.
Sheep	8,571	8,149	7,888	10,640	11,540	10,837	11,351	10,281	11,935	11,015	10,843	13,884	12,095	10,184
Cattle	466	615	645	449	382	609	575	549	541	521	510	487	497	492
Pigs ...	1,453	1,560	1,608	1,272	1,736	1,589	1,356	1,554	2,046	1,910	1,174	1,531	1,909	1,801

COMPARATIVE VALUES PER POUND.

Mutton	3¼d.	3¼d.	4¼d.	4¼d.	3¾d.	3¾d.	4¼d.	5d.	5d.	4¾d.	4¾d.	4¾d.	4¾d.	4¾d.
Beef ...	5¾d.	5¾d.	5d.	4½d.	4d.	4d.	4d.	4¾d.	4½d.	4½d.	4½d.	4½d.	5½d.	5½d.
Pork ...	6½d.	6d.	5¾d.	5¾d.	5¾d.	5¾d.	5¾d.	5¾d.	5¾d.	5¾d.	5½d.	5½d.	5½d.	4½d.
Bacon	5d.	5d.	5d.	5d.	5d.	5d.	5d.	5d.	5d.	5d.	5d.	5d.	5¼d.	5¼d.

Merino Rams.

MARKET REPORT.

Messrs. H. J. Wigmore & Co., Ltd., of Wellington Street, Perth, have supplied us with the following information regarding chaff offered at auction in the Perth Railway Yards for the period June to August (inclusive). In all cases the prices quoted are for f.a.q. to prime wheaten chaff, packed in new bags:—

	Quantity.	Maximum.	Minimum.
		£ s. d.	£ s. d.
June, 1932	.. 830 tons ..	5 0 0 ..	4 10 0
July, 1932	.. 770 tons ..	4 15 0 ..	4 5 0
August, 1932	.. 630 tons ..	4 7 6 ..	3 17 6

During June fair supplies of f.a.q. to prime wheaten chaff arrived for auction, and at the beginning of the month f.a.q. to prime was selling at £4 10s. 0d.; f.a.q. at from £4 2s. 6d. to £4 5s. 0d. per ton. Towards the end of the month the market firmed to £5, and f.a.q. realised £4 10s. 0d. to £4 12s. 6d. per ton. During the early part of July the market remained at around £4 15s. 0d., but towards the end of the month values eased to £4 5s. 0d. F.a.q. changed hands at from £3 15s. 0d. to £4 2s. 6d. per ton. Notwithstanding the shorter supplies of chaff that were available for auction during August, the market declined still further. F.a.q. to prime sold at from £3 17s. 6d. to £4 7s. 6d.; f.a.q. from £3 15s. 0d. to £3 17s. 6d. per ton.

Oaten Chaff.—During the same months of June, July, and August prime quality was scarce, and some was in demand at from £4 7s. 6d. to £4 12s. 6d.; f.a.q. from £4 2s. 6d. to £4 5s. 0d. per ton.

Oats.—Throughout the period under review the market remained steady, the closing quotations being as under:—

June, July, and August:

Good heavy feed Guyras and Mulgas	2s. 3d. to 2s. 5d. per bushel.
Good feeds	2s. 0d. to 2s. 2d. per bushel.
Light feeds	1s. 8d. to 1s. 9d. per bushel.

Wheat.—During June f.a.q. found buyers at from 3s. to 3s. 5½d. per bushel; second grade, from 2s. 10d. to 3s. In July f.a.q. realised from 3s. to 3s. 3d.; second grade, from 2s. 10d. to 3s. per bushel. We are pleased to report that during August the market firmed from 3s. 3d. to 3s. 5½d. per bushel; second grade changed hands at from 3s. to 3s. 2½d.

We have a good inquiry for all produce lines mentioned above, and farmers consigning to us for sale at auction can be assured of securing the highest market values, and prompt returns.

PRODUCERS' MARKETS CO-OPERATIVE, LIMITED.

QUARTERLY REPORT FOR THE THREE MONTHS ENDING 12TH SEPTEMBER, 1932.

Fruit.—Supplies throughout the quarter have been very steady. Apples, with the exception of two or three sales, have been selling at steady rates; at the end of the quarter Granny Smiths touched 14s. for 2½in. and 10s. 6d. to 11s. 6d. for 2¾in.; other varieties, 9s. to 10s. 6d. Navel oranges in the first month sold at satisfactory rates and at the end of the period firmed, prime quality realising to 14s. 6d. per bushel case. Lemons throughout were dull, but with the advent of warmer weather prices should improve for this fruit. Tomatoes from the Geraldton district were forwarded during the second month under review, but the crops being planted too early the quality of the tomatoes was poor and low values resulted. Mandarins were well supplied, consisting mostly of small and sour fruit. Good lines realised high values. Cape gooseberries and passion fruit short, with values firm.

Vegetables.—Supplies throughout the quarter have been very steady, and a steady demand was maintained for good quality country potatoes. Values showed little change. Metropolitan new dug lines were also in request, but values steadily firmed all the time. Swedes were plentiful, and inferior lines dull. Choice lines of graded were in demand and values were well above the average. Pumpkin values were low at the commencement of the quarter, but special lines were in better demand later. Cabbage supplies were heavy during the early part of the quarter and values were low, but with the shortening of supplies of other lines of vegetables prices firmed considerably. Beans improved considerably after the first frost. Geraldton crops were light, and all good qualities sold well. Peas ex Geraldton were also in good demand, local supplies being very short. Cauliflowers were heavily supplied during June and early part of July, but from then until the middle of August values were firm. Top prices for the season being obtained during this period. Rhubarb values firmed sharply; about the middle of the quarter held firm. Celery plentiful, principally from the York district. The quality this year was splendid, but values were lower than generally realised for this crop. In the bunch section beetroot and turnips were plentiful and values easy. Carrots were steady throughout. Parsnips of good quality firm. Lettuce also in good demand at firm rates.

Eggs.—During the quarter under review supplies both from the metropolitan and suburban districts commenced to show a noticeable increase towards the middle of June, and this increase had the corresponding effect of causing values to ease. During July supplies were still further increased, with the result that export operations were commenced about the middle of the month. The quantities packed for export had the desired effect of relieving the local floor and keeping values stable. The prices offered by export agents for exportable eggs has been a blessing to the poultry farmer, and as long as these prices are offering present values on the local market will be maintained.

Poultry.—During the quarter under review supplies of poultry have been heavy, with all prime lines in demand, with values much higher than those ruling during the previous twelve months. At present turkey hens and gobblers are offering to a keen demand at satisfactory values.

METEOROLOGICAL INFORMATION.

STATIONS.	Temperature.				Rainfall.		Temperature.				Rainfall.		Temperature.				Rainfall.	
	Maximum.		Minimum.		For Month.	Average.	Maximum.		Minimum.		For Month.	Average.	Maximum.		Minimum.		For Month.	Average.
	Mean.	Highest.	Mean.	Lowest.			Mean.	Highest.	Mean.	Lowest.			Mean.	Highest.	Mean.	Lowest.		
	JUNE.						JULY.						AUGUST.					
					inches.	inches.					inches.	inches.					inches.	inches.
Chapman State Farm	67·7	76·3	46·1	36·8	1·82	4·30	65·6	74·5	48·0	42·2	3·66	4·03	64·1	73·7	46·0	36·3	5·56	2·64
Geraldton	69·5	76·0	52·5	41·2	2·93	4·79	68·1	74·0	54·2	47·2	4·91	3·90	67·0	78·2	51·8	39·0	4·51	2·86
Walebing	63·2	71·0	41·2	29·0	3·06	4·03	62·3	78·6	43·8	37·7	4·96	3·77	64·5	75·0	41·2	32·0	6·45	3·06
Perth	65·3	73·0	48·8	38·4	6·47	7·03	63·4	68·3	49·9	42·0	9·72	6·72	61·4	77·4	47·3	40·5	6·13	5·73
Kalamunda	60·1	68·2	48·9	39·0	6·47	8·27	59·4	65·0	46·8	40·0	11·82	8·57	58·1	73·8	44·4	39·0	8·02	6·86
Bunbury	63·7	69·0	48·9	36·4	4·62	7·23	62·4	68·0	47·5	38·5	4·85	6·91	60·9	71·4	45·5	35·4	2·77	5·31
Bridgetown	61·7	69·0	41·8	33·0	7·84	5·88	60·0	68·0	40·1	30·2	6·73	5·78	59·3	72·0	39·7	31·0	5·44	5·09
Albany	62·9	70·0	48·7	41·0	4·67	5·44	60·5	67·8	46·2	38·0	5·48	5·61	59·6	74·0	46·1	41·0	9·75	5·21
Merredin State Farm	62·7	75·2	41·6	30·2	0·69	1·91	60·4	68·9	43·0	36·0	2·31	1·88	59·1	74·3	39·9	31·5	2·83	1·45
Northam	64·5	72·4	41·5	32·0	2·24	3·29	62·2	70·0	43·6	36·2	5·73	3·48	61·0	76·0	41·6	34·0	5·36	2·57
York	63·6	72·0	40·7	30·0	2·16	3·34	61·8	67·5	43·1	34·0	4·70	3·43	60·2	75·0	40·7	32·0	4·45	2·81
Narrogin State Farm	60·1	70·0	42·1	30·0	2·54	3·68	58·4	63·4	40·7	34·0	5·45	4·20	56·1	69·3	39·7	28·8	3·58	3·16
Katanning	60·3	69·0	44·7	34·3	3·54	2·93	57·1	63·7	42·0	33·0	5·24	3·07	56·8	69·0	42·5	32·1	2·47	2·47
Cape Leeuwin ...	62·2	67·2	55·2	50·0	8·54	6·86	60·2	64·2	52·4	45·8	7·55	7·29	58·9	69·8	51·0	47·0	5·92	5·27

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